59.

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NEW VIEWS

OF

MATTER, LIFE, MOTION,

AND

RESISTANCE:

ALSO

AN ENQUIRY INTO THE MATERIALITY

OF

ELECTRICITY, HEAT, LIGHT, COLOURS, AND SOUND.

To be Published Monthly.

BY

JOSEPH HANDS, M.R.C.S., &c., &c.,

Author of "Will-Ability," "Beauty and the Laws Governing its Development," "Homœopathy contrasted with Allopathy," "A Dissertation on Diets and Digestion," &c., &c.

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LITERARY NOTICE.

We have been favoured with a perusal of a portion of Mr. Hands' Work on "MATTER, &c.," and can speak of it as a most able and interesting contribution to scientific literature.—*The Modern Physician.*

May, 1879.

PRELIMINARY REMARKS.

It is intended in the following pages to point out certain novel characters in regard to the influencing attributes of Matter—by displaying through particular facts—the true agency that the atomized and unatomized or ultragaseous worlds, exercise in the economy of Nature. Added to which, will be an investigation into some of the more abstruse Laws governing the various kinds of Motivity. Also an inquiry touching the action of the Life-Principle as it manifests itself, whilst governing the development of the vegetable and animal kingdoms. Further, the Materiality of Electricity, Heat, Light, Colours, and Sound, are considered, demonstrating that these principles have most of the characteristics of corporalities—save that of ponderability or weight. In addition, will be a disquisition touching the qualitative causes of Resistance, and lastly will be annotations on Geology and Astronomy.

DEDICATION.

The following disquisitions are inscribed to the contemplative and expectant philosophical inquirers of the present day, with the earnest anticipation that they may be incited to examine more profoundly into modern discoveries, and thus arrrive at that epoch wherein shall be displayed infinitely more wonderful disclosures than any at present developed; bestowing on mankind new fields of knowledge, which, with their uses, as yet lie buried deep in the bosom of beneficent nature.

These forthcoming expositions will also be found to lead those who do or shall believe *only* in the existence of ponderable matter, to unmistakably discern that this substantive entity—upon which so much of their *faith* rests, and to which they attribute almost every capability—is unequal, by itself, to develop or be the evolutionary cause of any one event or occurrence, however simple that incident may be.

I am impressed to state, with the greatest confidence, that the future inquirers into science and philosophy will be enabled, as time rolls onward, most positively to demonstrate that all results—whether natural or mechanical—must be developed or brought about, either through imponderable spiritous-matter, as heat, electricity, magnetism, &c.; or through certain weightless spiritual-material essences, such as the life-principle of the vegetable and animal kingdom; and lastly, the supereminent, reasoning soul-element pervading the system of man.

(*a*) " When Bishop Berkeley said there was no matter,
And proved it, 'twas no matter what he said."
Don Juan, Canto xi.

(*b*) If thought was a capacity of matter, the rock, like the man, should be endowed with a thinking capacity.

(*c*) Men of science mostly occupy their time and abilities in contemplating or examining into the productions of Nature, rather than employing their energies in searching after the modes through or by which she fabricates and evolves the sequents of her labours.

(*d*) As regards ponderable or gravitating matter, I would ask, Whence came it, and to what final end does its economy tend? Further, how much of it, when called into being, is persistent, and what portions of it are evanescent?

(*e*) Nature whilst fashioning her ponderable productions (unlike mathematicians during their artificial labours) never employs circles, right-angled cubes, and squares or straight lines; nor did she ever form in her economy a non-polar sphere, but, on the contrary, all her evolutions, as to outline, tend to the ellipsoid, rhomboidal, hexagonal, curvilinear, and obovate, configurations. Relative to the latter figure, whether imagining the form of an atom, contemplating the feature of a dew-drop, or the shapes of the fruits of the earth, each is ovate, or resembles the planetary and solar systems in being flattened at their poles. In addition, all the grand productions called into being, and useful discoveries made in the arts by man or woman, were brought to light mostly by persons incapable of measuring the magnitudes and bearings of things or objects by means of figural calculations.

(*f*) Wherever matter exists, there must follow motion, and in all regions where these obtain—as regards the superficies of conglobate worlds—there must be life.

(*g*) The suppositious and indefinite thoughts of philosophers are mostly of little or no use—in fact, they are generally injurious by reason of tending to prevent instructive inquiry. Every individual, whilst interpreting, should speak and write concerning that which he *knows and comprehends*, and never indulge in conjecturalities.

(*h*) It is the knowledge of facts—the result of experience, and not theories and hypotheses—which teaches or calls forth wisdom.

PREFACE.

The present Essay on Matter was in part commenced as far back as 1845, at which period I held fast to the doctrine of Materialism.

During the above-named year it was my fortunate destiny to meet with a case of clairvoyance, which natural phenomenon became developed through my own manipulations, and at a first sitting. I would here remark, that this most extraordinary ability burst unexpectedly upon my senses, and in an instant swept away all distrust as to the being of a soul, or of its future existence; and this after I had professed scepticism—as regards these subjects—for many years.

The predominance of these doubts led me, during a long period of ignorance, to associate with the crowd of unbelievers, instead of gleaning knowledge through self-experience, by walking in that path trodden by the few, in which were realised the eventful facts, that alone could have convinced me of my erroneous persuasions. It may be here mentioned, that the individual first experimented upon by me was the afterwards celebrated Ellen Dawson, who, at the time of my mesmeric applications, was labouring under frightful disease of the heart, of which she became rapidly cured. Since this—my first effort to heal "by the laying on of hands"—I have called forth the transcendant ability of clear-seeing, in forty-seven different patients, of all ranks, from Madame la Comtesse down to the peasant-girl, and from the simple school-boy up to the man of letters; yet I once presumed to deride this lucid capability, thinking that all who confessed to the fact in question were either mad, foolish, or untruthful; though that fact had been announced as a verity in all ages of the world, equally by the thoughtful and learned, as well as the wise through experience. I would pointedly confess that it was this luculent capability—and that alone—appertaining to the animal economy, which precipitated me from my materialistic throne, upon which I had so long placed myself in ignorant exaltation.

It may be as well, perhaps, here to state by way of creating confidence in my perceptive faculties, that I had for many years of my life, previously to witnessing clairvoyance, been a diligent

and successful teacher of men, which occupation may serve to vouch for my industry whilst walking in that path in which can be acquired so much knowledge—"for by teaching we are taught." I would, moreover, announce, in order to attract additional attention to my capabilities of discernment, that I had the advantage of being under the tuition of the first masters of the age, among whom I may mention Professors Owen and Faraday, &c. Further, there was a period in my existence, when I at times flattered myself that I was well versed in most of the phenomena belonging to natural and experimental philosophy; and I had also arrived at the conclusion that most of the principles taught in the schools were correct. But experience and reflection have shown me, that much appertaining to the teachings of scientific professors are but empty theories, which are found to crumble into "shadowy nothings" when tested and explained by the capacities of clairvoyants. Apologising for these personal observations, I would observe, that this clear-seeing ability was often developed in and exercised by those rather deficient in organisation and often void in education. This simplicity of character will be readily recognised, when it is known that many of these seers were quite young, and some of the more advanced in age were wanting in worldly experience; yet, notwithstanding these defective conditions, they, in the clairvoyant state, could readily read the history of the past, and prophesy accurately of the future, and also well and correctly describe the phenomena which were transpiring in Nature's laboratory, and likewise clearly define the whereabouts and growth of certain minerals and springs of water, hidden in or under the earth. In addition, they could point out the internal workings and economy of the living plant and animal, and were most astonishingly versed in cause and effect. Again, they could successfully prognosticate concerning disorder and disease, and prescribe for and heal the sick, after the same manner as did the Pythoness and Prophet in the Temples, or rather Hospitals, of the ancient Eastern Therapeutæ. There is one character belonging to these clear-seers we would mention: that they never attempted, if honest and truthful of purpose, to *guess* or *surmise* when or how certain future occurrences or condition of things would transpire, but mostly—and without any noticeable effort—decided after what mode coming events and circumstantial effects would be unfolded. It might be stated, by way of creating more confidence in my assertions relative to the capacities exercised by clairvoyants, that the foregoing facts did not rest upon my own discernment or perceptive abilities alone, but were witnessed and attested by very numerous truth-seeking companions, who surrounded me whilst

I was exploring in these fields, once held sacred, which are still, as yet, shut out from the rude entrance of the doubter and the general world. I would moreover state that my fellow-examiners into the above phenomena were men of the first education and endowed with very capable intellects, numbering among them persons of the highest rank, professors of physic, law, and divinity, to whom may be added many of the first authors of the day. For a list of their names I refer the reader to my work on "Will-Ability." I would, in summing up, again beg leave to apologise to my readers, for the positive language in which this article is written, as well as for the individual statements discussed; but, the intense desire I feel to incite future investigators to enter upon and explore this at present obscure path in which I have reaped so much wise experience and enjoyment, must plead my excuse for the somewhat arbitrary diction of this introduction and following essays.

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PROLEGOMENA.*

According to the theories designed to be inculcated in the following disquisitions on Materiality, it may be necessary to suggest, that I deem the primary ethereal elements of unparticled or undeveloped matter to be at first atomised or corpusculated in Nature's creative laboratory, by the growing organisms that surround us, and thus they become the vital molecules which constitute the component parts of living entities. And be it further observed, that when these organised forms die, and their tissues become decomposed into gases, vapours, dust, &c., Nature can never again directly employ these results of decay, either in their supposed simple state (as that of carbon, oxygen, &c.), or in the compound condition (as under the express form of water, ammonia, carbonic acid gas, &c.), to feed upon or form any new or fresh productions that may appertain to the animal and vegetable kingdoms. Be it understood that when organic matter, obeying the laws of the universe in the economy of vital structures, returns to its original character of unparticled, non-resistent matter, then alone is it available for the building up of a new succession of organic forms.

It is necessary that my readers should constantly bear in mind, that the superficial stratified rocks and earths of which our globe is constituted were all once pregnant and quickened with a life-principle, and owe their primary origin to the animal and vegetable kingdom of the past and present eras.

The views hereinafter advanced may be summarised in the following propositions :—

I. Matter primarily exists in an undeveloped, unparticled, or non-resistent form, of which by combination our simples, such as carbon, oxygen, &c., are composed.

II. All matter in its transformation from one organic form to another, as in the nutrition of plants or animals, has to return to the primary unparticled state before it can be applied to the building up of the structure which it is destined to nourish.

* *Prolegomena* (Greek), Preparatory discourses or preambles.

ESSAY ON MATTER.

1. Matter.*—(*a*) What is it? Whence came it? And what are its varied economies, whilst obeying the laws which direct and preside over its every change—whether in motion or *apparently* at rest? (*b*) How much can we at present comprehend of the qualities and capabilities of matter beyond its physical bearings? (*c*) Relative to the ultimate principles, the combination of which form our present supposed simple or single bodies† (the non-compound ponderable elements of the schools), what know we? Lastly, the question might sometimes be asked, and with reason, relative to many of the very unstable conditions of certain kinds of matter, What has become of it, and whither has that objective substance gone that we, a short time since, palpably handled or contemplated, and under what character will it again affect our senses? What satisfactory response can be made to these questions? Of the ultimate nature of extended materials, the human faculties, as commonly employed, do not take cognisance, nor can the data be furnished through observation or experiment (by our present recognised senses) on which to found an abstract investigation of it. All that is at present supposed to be known of ponderable bodies are their general properties, as perceived by our five recognised receptive faculties. The contingent qualities of material existences are said to be mobility and weight. The essential attributes of matter are stated by the ancients to be (1) Divisibility, (2) Impenetrability, (3) Porosity, and (4) Compressibility.

2. In the current period, though amid vast sources of knowledge, all of which tend to lead to new discoveries, we are constrained to confess that at present we can understand or surmise very little, if anything, of the naturally obscure tendencies or operations one upon the other, of the elements constituting what has been termed matter. It is conjectured that whatever event or experience has been im-

* Matter (*materies*), substance.

† As carbon, oxygen, hydrogen, nitrogen, and the different metals, &c., &c.

pressed on any single atom or combination of atoms relating to matter, has also been stamped upon or imbibed by every other molecule in the universe, and will continue to be printed or photographed, so to express it, upon every succeeding group of corpuscles that shall in the future ever enter into combination with each other. In addition, we are especially lost whilst surmising as to the antecedent state of matter in the long past—when what we now term life or vitalised atoms, were a nonentity in anything or distinct formation. Our astonishment is still further enhanced as we make the attempt to comprehend—even in imagination—the shadowing forth of the primary action of the laws which predisposed and then governed and directed the disposition of the earlier material essences, whilst they were in preparation for the assumption of some of those properties, under which they are now presented to our very varied sense-receptive faculties; and it may be observed that a vast number of those properties and abilities have yet to be discovered, and their prominent uses pointed out.

3. In examining the leaves or strata of the globe we inhabit, it has been recognised, that there have been from time to time, immense changes in the mineral, vegetable, and animal kingdoms. We also further discover that there were added or developed at distinct periods, certain—at present conjectured to be—simple or unmingled bodies to the world's constituents, which had no being in an earlier era of the earth's existence, and that these unfoldments of materiality at subsequent intervals entered into combination, the one with the other, to form particular compound productions and associations, which became the antecedents of some of those bodies that now act upon our perceptive faculties. Many blended compositions—originally formed, as before stated, from unparticled or the ultimate elements of matter—have also been discovered to exist in some of the later crusts of our planet, which had no being in a former age, as to their present configuration and quality—such, for instance, as those belonging to some of the metals and their compounds. Be it also noticed that we in our laboratories—like Nature during her labours—are constantly, at the present period, chemically forming or creating new compounds, that have no being in the material world, as now known to us.

4. As out of nothing there can never originate a something, we are led to suppose, from witnessing certain developments, that there must be states, qualities, capabilities, and commixtures of imponderable matter, which have hitherto escaped, and for ages will perhaps still elude our capacities to grasp. Through these suppositions we are incited to infer, that the physical existences we now regard as simple or single bodies—as before suggested—are themselves compounded

out of certain tenuous elements of undeveloped or unatomised matter, the characters of which are so rare or subtile, that they have up to the present time escaped our intellectual energies to detect.

5. Whilst reflecting on this subject, I am led to conjecture that there was once a cycle when all the gravitating *material existences* we now behold, subsisted in a state quite as ethereal or unsubstantial as are the weightless elements now presented to our feelings or senses, under the forms of light, heat, electricity, and magnetism, to which we may add those of sound, colour, &c. There can be little doubt, that in the far back period of the eternity of time, unconcentrated or unformed matter entered into a closer intermixture with these said imponderable spiritous essences of sound and colour-exciting principles, and also with the luminous magnetic, electric, and calorific entities, than they do at the present time.

6. It would appear from certain evidences, that in the course of the unfolding of Nature's laws there came a revolutionary period when these subtilely-mixed or volatile elements separated into comet-like divisions.

7. The breaking up and the after-concentrations of the ethereal constituents, which once filled indefinite extension, into masses, gave rise finally to the formation of the different star-suns of the universe. Our world light-exciting orb at the present period turns on its axis once in twenty-five days, but when this luminary's circumference extended as far as the earth, the sun, from which our globe broke or was thrown off, required 365 days to effect a revolution on its axis, but when the periphery of the great luminary of day extended further into space, where it flung off the more distant planets, the time of its revolution was, of course, proportionately lengthened out.

In continuation: From these star-suns, whilst revolving on themselves, there broke loose, from time to time, their now accompanying planets, some of which latter in turn threw off certain rings,* like those belonging to Saturn, which at periods divided into moon-satellites, similar to those of Jupiter; and finally all became the attendants of the sources from whence they sprang, thus constituting *altogether* the vast luminous firmament, part only of which is visible to us. It may be further supposed that the conditions of the foregoing primary nucleated masses, after revolving through countless ages, mixing and remixing, first as "airy nothings" or unimaginable ethereal existences, then assumed the forms of thin vapours, which in time put on the character of tenuous fluids, that afterwards became

* Familiarly illustrated by the flying off sometimes from the outer edge of a grindstone, its rim, or margin, whilst rapidly revolving on its axis.

the liquid products, in which was formed certain soluble bodies, that by acting and re-acting on each other, through innumerable periods of time, finally approached the character of the elemental products now in being.

8. Out of heat, electricity, magnetism, and other subtile or rare principles originally constituting amorphous or unparticled matter, were developed the compound—as we presume them to be—atoms, monads, or corpuscles of the schools, of which the sphere we now inhabit is conjectured to be composed. Further, the different metals and their oxides, which in part constitute the rocks and soils that pen in the rivers and the mighty sea, with its world of waters, are made up of the molecular atoms so derived. The gaseous elements sustained by the earth and ocean, which enable us to live as breathing animals, owe their derivation to the same sources.

9. From the above conception of the origin of the formations out of which sprang all the physical existences that everywhere surround us, I shall pass onwards to the contemplation of other sequents, which have issued forth and are still emanating from Nature's laboratory; and while thus proceeding I will endeavour to picture the modes by which she effects her purposes whilst giving birth to the varied products she has presented to our senses; or I would, at least, try to make more particular inquiry concerning the why and the wherefore of certain results, which up to the present day have obtained but little notice from philosophers beyond the general records touching their individual being.

10. It may be suggested that the extreme tenuous or impalpable condition in which the vast world of matter once was (as previously suggested) can in part, as circumstances require, exist again. In fact, certain of these rare unparticled or unatomised corporeal elements (to be hereinafter d scussed) still obtain or have a subsistence, though we at present fail to demonstrate their positive form of entity.

11. In proceeding with our subject I shall endeavour to show that all kinds of matter—of whatever description or condition—are continually interchanging certain principles, and thereby altering their state of being, but the natural capacity of this action between distinct bodies, escapes at present our abilities to detect or display.

12. By comparing some of the supposed simple or undecomposable elements of the schools, one with the other, under different circumstances, or rather conditions, to what hitherto they have been examined, we shall be enabled to form a better conception relative to their—as before noticed—compound states, and consequent bearings in the economy of Natur e.

13. In searching into the characteristics of hydrogen gas, we discover that when uncombined with other ponderable bodies, it is the most rare, and lightest known material, with which we are acquainted. It should also be remembered that under certain conditions, this gas is capable of assuming, like nitrogen—the chief constituent of the air we breathe—the property of a metalloid. It is also found that hydrogen is capable of combining (after the manner of some of our heaviest metals) with definite proportions of certain gaseous elements. Thus, we can oxidise hydrogen, by uniting free electricity with it, in the presence of oxygen, or by burning it when exposed to this latter gas; through either process the protoxide of hydrogen or common water is formed, which consists of two measures of this last element and one of oxygen. It may be here noticed that aqueous fluids may be crystallised by the abstraction of heat, and contrary to almost every other substance in nature, water is increased in volume by solidification. But to return, we can also by a chemical process peroxidise hydrogen; moreover this subtile gas is found to combine likewise with chlorine, forming hydrochloric acid or spirits of salts. Similar unions to the above may be produced with the vapour or fumes of metallic mercury (quicksilver) when brought into contact with oxygen and chlorine; these latter gases also readily combine with any of the other common metals, especially when they are divided into very small fragments, or reduced to extremely thin leaves. Their union is likewise greatly assisted—as to time—by the addition of heat; with others, the junction is intensely hastened by employing currents of electricity or galvanism. It may be further stated that heat, electricity, and magnetism, and most probably light, colour, &c., combine in a greater or lesser quantity—according to circumstances—with all substances, whether simple or compound; but it is very different with the ponderable atomised corporeal bodies: they only chemically unite with particular and definite kinds of other single elements, and always in given proportions.

14. I would solicit my readers to entertain with me the supposition that we had discovered the mode of resolving this said hydrogen into its ethereal physical constituents or ultimate elements of imponderable or unparticled matter. If this could be accomplished, we should then be made aware, that the separate elements of which this gas is compounded, would be more subtile than the spiritous matters (so to call them) presented to our senses under the form of heat and electricity with mineral and animal magnetism, &c.

15. In the opening paragraph of this essay, I put the query—Under what laws does matter so often change its character, and after what manner does it sometimes disappear to our senses and appa-

rently occupy no space? I am impressed to here ask another question. Where is the locality in which matter is not? It doubtless exists as an imponderable non-resistent element in the far far away, extending into the unimaginable expanse beyond the apparent blue dome we have so often looked upwards through, in joy or in sadness. Newton attempted to calculate, by means of figures, the density of the rare ethereal form of matter, which extends beyond the confines of our atmosphere into infinite space, constituting that great ocean of scarcely ponderable medium, in which the orbs of our system roll in their respective paths, and he proposed that it must be 700,000 times less heavy or more light than the air we breathe.

16. This so-called tenuous and apparently intangible matter can also have an existence and locality between the molecules or atoms making up the living and lifeless objects that surround us. The latter proposition may easily be assumed, for as we proceed with our subject, we shall place before the reader certain facts, where one of two palpable corporeal bodies appear—as far as the visual organs are concerned—to occupy no locality when mixed together.

17. It is a well-known experience, that we can only become conscious or sensible of the existence of distinct objects through the properties that belong to or emanate from them, by means of certain qualitative undulations. If any of these issuing attributes, that act on our varied and numerous perceptive senses, become altered or quiescent, then the aspects and even the forms, under and through which we recognise things, disappear, and the bodies in question would then not be themselves—as it were, and thus conditioned they must present to our receptive sensations something else than what they were before the alterations effected in them—by abstraction or addition—had taken place. Among some of the characteristic attributes of materiality which make us acquainted with the being and state of external things, may be enumerated: life, death, attraction, repulsion, form, size, weight, hardness, softness, sweetness, and bitterness, to which may be added, colour, odour, and sound. These three latter belong to the family of elementary spiritous matters, like light, electricity, magnetism, and heat. We would further reiterate that without these said undulatory or vibratory spiritous elements, and those emanations which become impressed upon the sensitive surfaces of our nervous systems, we should never have known or recognised the existence of what is commonly called crude material entities.

We will illustrate the subject in question by calling attention to the changes which ensue, as regards some of the metals, whilst being chemically or otherwise acted upon.

18. If we examine pure mercury at common temperatures, we

shall perceive it to be a brilliant heavy fluid. By abstracting some of the spiritous matter, commonly called heat, from this silver-like liquid, it then becomes a malleable dense solid; on the contrary, by adding a sufficient quantity of caloric to this metal, it now puts on the character of vaporous fumes. Further, accordingly as we oxidise mercury, we can either form a grey powder—the protoxide, or red scales—the peroxide—of this metal.

19. In extending our observations to the changes of substances as regards their qualities and appearances, it may be noticed that if we combine the oxides of most metals with acids, they then form soluable salts, as alum, soda, potash, sulphate of iron, zinc, &c. These latter states cause different bodies to be deprived of all their former characteristics.

20. By dissolving some of our anhydrous* metallic salts in water, we lose sight of them altogether, as far as their occupying any apparent space is concerned, for none of the aqueous fluid—if pure—in the vessel will be displaced by the careful addition of the dry or waterless salt.

It has long been demonstrated that salts containing water of crystallisation, dissolve in fluid without increasing its bulk more than is due to the water present in the solidified salts. This fact was first observed by Dr. Dalton, who remarked that certain hydrated salts, on solution in water, increased its volume by a quantity precisely equal to the proportion of water held in combination. Thus, from the foregoing we see that each mutation causes a transfiguration, or difference in the quality of substances, and consequently their properties and appearances are metamorphosed, as far as general recognition is concerned.

21. Having traced in the foregoing sections, some of the changed aspects and capacities assumed by the metals under differing circumstances—as when pure and in combination—we may perhaps, with advantage to our subject, mark down some of the varied conditions of carbon, as found alone (that is in its simple elementary state, as it is presumed to be by the schools) and in combination with other bodies.

22. The uninitiated would never conjecture that the diamond was merely crystallised charcoal, but the educated experimenter well knows that this gem will burn rapidly, like a piece of fuel, when heated in oxygen gas, and the sole product is carbonic acid. In addition, charcoal at a very high temperature can exist as a vapour, whilst over red-hot iron, as in forming steel, or when *in vacuo*, acted

* Anhydrous—as regards salts—without water of crystallisation.

upon by the galvanic current. It here passes from the negative to the positive pole in the state of an aeriform elastic fluid or fume.

Again, how different in its qualities and disposition is carbon when it assists in forming or becomes allied to the living tissue of an animal. The distinctive bearings of this material is again varied, as met with under the form of coal. No one unskilled in botanical physiology would at first imagine that this same principle—under another form—constituted the base of the living tree in the forest and the herb of the field.

23. I am further impressed to ask the question, How, and in what way, does carbon originally or primarily enter into and make up the chief constituent of plants? The growing vegetation does not obtain it, under any of the phases known to us, from the air, or from the soil, as evidenced—relative to the latter—by shrubs being enabled to increase in size, though growing out of the stony crevice of an otherwise barren rock. Some plants may be seen to shoot and become developed, even while suspended in the atmosphere by a piece of string, or hanging from the limb of a tree, &c., as noticed with some of our aërial vegetation, and certain creepers, cryptogamic mosses and floating aquatic plants. (Relative to air-plants, this name is given to any kind of vegetation which grows without roots penetrating the earth). The most extensive natural order in which air-plants are found is the *orchidaceæ*, thousands of species of which literally crowd the forests of hot climates. Next to these range bromeliaceous plants, some of which will live for months suspended freely in the air, or tied to iron or stone balconies. Various species of *ficus* (fig-tree) and some *Gesneraceæ* have similar habits. The only real air-plant that grows wild in Great Britain is the *cuscuta* or common dodder, a curious thread-like twining plant found on some heaths. Again, the earth placed in a box or tub has been carefully weighed before a given tree was placed in its contained mould, which was again examined by the balance twenty years afterwards, without the soil in which the shrub grew being in any way diminished. In fact, the woody fibre of the tree so produced outweighed the box and its contents.

24. The carbon found in our surrounding vegetation, was not obtained from the air, for that is and ever has been, as a *law*, the same (except that local and very limited portion derived from the carbonised oxygen given out by animals and by plants in the absence of light and also at periods from certain portions of the earth) as it was thousands of years ago; in proof of which I shall place before the reader a few facts illustrative of my assertions.

25. It was discovered on examination that the air sealed up in a

bottle nearly 1800 years ago in Herculaneum, contained the same proportion of carbonic acid as it does at the present day, viz., one part in a thousand. This comparative quantity would be found to obtain whether we analyse the general atmosphere on the surface of the earth, or forty miles high on the summit of our aërial elements, by reason that gases act as *vacua* to each other.

26. It was formerly conjectured by some hasty reasoners that at the period when the plants and forests were growing, which finally formed the coal-strata, the atmosphere of the earth was chiefly composed of carbonic acid, in order, as they supposed, to supply the then vast vegetation with carbonaceous food. But mature reflection and certain facts teach us that such a condition could not have obtained; had this been the state of their surrounding medium, it would have acted as a poison to the *then* plants, as it would to the *now* animals. It is very well known from experience that the botanic world can only tolerate a certain proportion of carbonic acid in the air, viz.: one in a thousand parts; if a greater quantity prevailed, the tree and herb would become poisoned, and of course perish. Some trees, and especially the fig, are always exhaling carbonic acid, both by day and night. It has long been very *questionable* whether plants can take up oxygen or carbonic acid direct from the air. It was conjectured by some individuals that the vegetable world became nourished from the ammonia that pervades, more or less, the atmosphere; but I shall in the course of my article *prove*, I think, that if the botanic world does absorb the above-mentioned bodies, it instantly decomposes or de-atomises them into their ultimate pristine amorphous imponderable elements, and in this way they may *assist* in materialising the vegetable kingdom, which latter, I shall presume to state, is chiefly, if not altogether, built up from the above unparticled and weightless matter, which is everywhere diffused, even throughout unimaginable space, and doubtless is the only *original* source of the growth of animals as well as plants.

27. It should not be forgotten whilst on this subject, that in general the vegetable kingdom does not take up, nor can it create or form carbonic acid but in the presence of light and actin; and of course the more intense the aërial lucidity, the greater the proportion of acid consumed, or rather carbon formed by the in-born economy of the plant itself. Now as the sun's magnetic rays*—which rouse by electrical action the heat and light constantly present in our atmos-

* The luminous atmosphere of the sun is unquestionably not the result of an igneous process—as generally understood—but ensues from a continual motive electrical action going on in its aeriform metalloid elements, as hydrogen, iron, &c., &c.

phere—were the same in quantity and quality, according to the seasons or other variations, millions of years ago as now, of course there could not have been sufficient aërial light roused into action to incite the different plants to form more carbon, or take up a greater portion of carbonic acid from the air, at that far back period, than they could be enabled to accomplish at the present day.

The light and warmth of the earth and air only in part, as before noticed, emanate from the sun, but are contained in the atmosphere and the constituents of the planet we inhabit. The orb of day merely excites, by magnetic influence, these spiritous principles into action or more vivid motion; for it would be found that if our aërial elements were removed, we (supposing life to still pervade us) should never feel heated by, or see, the sun and stars again. Further, even if the common dust, as shown by Professor Tyndall at the Royal Institution, the bactria, cryptogamic sporules (the reproductive powder of certain plants) with the thousand other atomic scoriæ, or *débris*, and floculent shreds which now pervade or float through the air, were removed, our apparent sun-lit dome of the day, and the star-studded canopy of the night, would be for ever shut out from our capability to recognise them. In fact, all objects would disappear from our *common* sight, and we should be enwrapped—as far as the sun and stars are concerned—in impenetrable darkness. To illustrate that heat and light are always present in our atmosphere, can be shown by employing in a dark room a transparent glass cylinder, in which has been fitted a well-adapted piston, and suddenly condense its contained air by driving down the said piston, we shall be able to elicit, or squeeze out, so to speak, both light and heat. This result will be evidenced by the luminosity called forth by compressing the air—like the sparks generated by the attrition of the flint on the steel; further, relative to the heat, a sufficient quantity will be compressed or set in action to ignite a piece of phosphorus placed at the bottom of the glass tube. Again, the electric fluid as it suddenly flashes through the atmosphere demonstrates that heat and light form a part of the air we breathe.

28. In further noticing the constituents of the atmosphere it may be remarked that the eyes of the animals which had an existence in the earlier ages of the earth's being were constructed after the form and economy of those their now existing prototypes. The facets (faces) of the organs of vision belonging to these creatures—so long locked up in the rocks like gems in their setting—were fashioned to be employed in an atmosphere of the same density as the one in which we now live and recognise objects. This latter circumstance relative to the formation of the eyes of animals most positively forbids us to entertain the conjecture put forward of the aërial element being

composed of other permanent constituents than those at present found in it. In fact, the component parts making up the atmosphere are arranged according to a positive and necessary law or economy of nature, and must have been the same ever since vegetation and animals existed, and will continue so to be whilst life pervades the earth.

Persons in general have no conception of the absolute and essential bearings of Nature's order of things. But the reflective mind of the philosopher perceives, or is aware, that if any one of the general laws which pervade the universe—as, for instance, the polarity of the atoms appertaining to all bodies—was to be changed or interfered with, if only for a fraction of a moment, over even perhaps a part of the *great whole*, all the vast worlds in existence and their constituents would melt into a "nothingness," and matter would again become, as far as our present senses are concerned, unatomised or unmaterialised, from this one failure in the ruling action of Nature's government.

29. As a sequence to the foregoing points, I am led to inquire, From whence was derived all the combined carbon found in our rocks and soils, also that which has been locked up in the different coal-strata and in peat-bogs, or deposited—at a later period—as vegetable mould, which in some of the forests of America has been discovered extending to a depth of twelve to fourteen feet? I would also ask the same question relative to the derivation of the carbon now existing in the present living vegetation and animals. It could not have originated from the circumambient air, or an alteration in its present proportional constituents must have ensued, especially relative to its contained carbon; for it is a self-evident axiom, that we cannot take away a part from a body, and leave the mass as it was before the separation. Further: Where do the deep marine plants and sea animals obtain their constituent carbon? This element is not found in the ocean, except just upon its surface, where it becomes exposed to the modicum of carbonic acid resident in our atmosphere.

30. These circumstantial results lead me to conjecture that as this locked-up carbon was not derived from the soil or the atmospheric medium, it must consequently be a compound body, made up—as before suggested—of certain principles or unatomised elements which have up to the present time escaped our abilities to detect. Admitting the foregoing to obtain, the growing plant and animal must have the capability of *condensing* or causing the union of these inconceivable, uncorpusculated existences—a combination of which form the substance we designate carbon or charcoal. The foregoing economy must also occur relative to the origin of some of the metals and other substances. Thus we find potash, the base of

which is the metal potassium, present in the ashes produced by the combustion of aërial plants. Again: in the blood of land and sea animals we meet with iron, yet this metal is not found mixed up in the sea or air. It is true, iron is sometimes found very slightly diffused through the atmosphere, once or twice a year, whilst the earth is passing through the belt of aërolites which revolve round the sun. —(See "Astronomical Matter.") Further: Relative to the origin of the metal calcium, the base of lime, Whence do the shell-fish and corallina with other marine animals obtain carbonate of lime, which form the frames of some and the cases or coverings of other inhabitants of the ocean? Certainly not from the sea-water, for that scarcely contains a trace of this substance, except at the mouths of rivers, which portion is soon deposited to assist in forming the different deltas found at the termination of the various streams that empty themselves into the mighty ocean of waters which fill up the deep cavities of the earth. In fact there is a greater quantity of carbonate of lime formed and deposited by some of the families of the corallina, *in a few years*, over one of our great up-growing marine submerged islands, than all the lime that was ever found or existed in the broadest and deepest seas. The same question might be asked relative to the house-snail and land-crab, which latter is often found casting its shell on the common earth or grass, where it creates or secretes a new covering, though enwrapped only in a few leaves, in which exists no lime. From whence again comes the lime which forms the bony structure of the bird whilst within its shell? There is none in the soft parts of the egg, nor is there any vascular connection between the chick and its calcareous covering; and if there was an association it would be discovered on examination that all the lime of the entire shell would not be equal in weight to the quantity found in the osseous frame of the young bird, when first breaking its prison-wall. Further: The egg itself is secreted and produced by the parent bird, which swallowed no lime, nor was it present in the food it fed upon.

In continuation: All the carbonate of lime, and each particle of our chalk-beds, were originally formed by living creatures. Every atom we look upon belonging to the earth's upper strata, was once instinct with animal or vegetable life. It is the calcareous shells of the animalcules termed Foraminifera that form the white stone of which Paris is built.

31. It may be perceived from the foregoing remarks, that plants have the capacity of collecting certain tenuous or subtile imponderable elements to form carbon, and likewise to produce metals, as shown with potassium and iron; and it has been also pointed out that a set of definite animals, as the zoophytes and shell-fish, are capable of

arranging or attracting together certain amorphous principles with which they form lime.

32. Relative to the animal and vegetable origin of silicium, the base of silica or flint, we have abundant evidence of flint formation by some vegetables, as in the cane tribe, and likewise by a particular race of animals.

Appertaining to the latter class may be noticed various infusoria possessing silicious or flint shells, which shells these animals secreted, or rather they had the ability to attract certain ethereal unparticled principles resident in the waters they inhabited, by means of which they formed silicium, this latter being united to the pristine elements that go to form oxygen, constitutes silica,* of which these cases are made up. Now the fluids wherein these flint-producing creatures are generated do not contain silicium or its oxide, silica. This sequence of things proves that Nature possesses or exercises an alchemy of which we as yet know nothing beyond the bare fact of the existence of her productions. Yes, Nature has an occult chemistry of her own, by means of which all organic and inorganic bodies are formed and afterwards arranged. She at distinct periods has collected or brought together into her laboratory, the different *unatomised ethereal elements* with which she has fashioned the earth, and is now creating the trees and shrubs of the forests, and the vegetation and flowers of the fields, that in turn through her means will help *in part* to develop or at least influence the varied living beings surrounding us. The subtile unparticled and imponderable principles that Nature *employs* to perfect her productions are very unlike those at our command, as is the *procedure* in executing her work. The economy of Nature's operations is, and ever will be, during our earthly sojourn, a mystery to us. The veil that now hides so many of her secrets, will only be raised to reveal them in the schools of a future state.

33. Different races or genera of the polygastric animalcules, as the *Grilionella* and *Bacillaria*, &c., have become fossilised, and furnish among other productions, the mineral *Polir-scheifer*, used for polishing purposes. Strata of infusoria have been discovered in different places, extending for many miles in circumference. Professor Ehrenberg noticed beds of *living* flint-producing animals—the *Destomaceæ* —60 feet in depth under Berlin.

We recognise in geology, that in past times the pulverised *débris* of these animals coverings' were perhaps fused, and thus formed the segments of the flint we meet with, or they may have been fashioned through the process of attractive cohesion, that builds up and lays

* This mineral silica, enters into the composition of many of our scintillating stones, as flint, quartz, agate, &c.

down so many of Nature's structures or productions. Other minerals belonging to this family—as quartz, jasper, agate, &c.—were crystalised, through magnetic influences, from different solutions holding in them the constituents of these stones.

34. *Touching the Porosity of all Solid Substances.*—It has been stated by Newton that matter is always permeating or passing through every physical existence, whether aërial, fluid, or solid. Voltaire asks why there should be passages through matter, if nothing traverses it?

The following facts illustrate the capacity of one substance penetrating another:—

(*a*) The Florentine philosophers, by means of a screw, pressed water through the pores of hollow golden spheres.

(*b*) It is by the quality of permeation appertaining to materiality that the particles making up different veins of metal were deposited in the solid rock. It has also been observed that certain metallic crystalline lodes vary according to the rocks they have traversed, and are often found lying north and south, as if stored there under *polar* influence; other metallic veins, differing in quality or kind, extend east and west, as if from *diamagnetic* action.

The capacity of the molecules of matter to pervade or pass through the various solids of the earth gave rise perhaps to many other deposits found in and upon the beds making up the different strata of the globe we inhabit.

(*c*) Serpents of the largest kind have been known, during confinement, as for instance in a box or cage, to hatch their young, and the offspring so produced have remained in their prison-abode until they trebled their original size, without the parent or her brood having partaken of any kind of food. The chameleons of S. America possess the capacity of living imprisoned for years, without taking food or losing weight. Whence, I would ask, came the sustenance through which the animals in the first case became enlarged, and in the second sustained? How and under what form was the nutriment conveyed into their systems?

(*d*) So long as the eggs of insects and certain other creatures are pervaded by the life-principle, they go on increasing in size, both before but especially during the hatching or incubative period.

(*e*) Dr. Carpenter in his "Animal Physiology," p. 177, relates the case of a jockey, who being weighed before the race, was allowed to take a glass of wine, shortly after; on being again put in the scales, at the request of another interested person, the jockey was found to be some pounds heavier than before partaking of the vinous fluid. Many similar cases have been reported by other persons. Thus another

rider, two hours after taking a cup of tea, was found to have gained six pounds.

(*f*) In a case of disease, I once knew a woman (Mrs. Smith of East Street, Manchester Square) who in the course of thirty days, discharged from the stomach, bladder and bowels, fluids, &c., nearly equalling the weight of her whole body, and this without eating and almost without drinking. Dr. Hooper relates like cases.

(*g*) A man affected with diabetes has voided in a short period 113lbs. more water than he had taken. Another patient drank forty-three pints of fluid in eighteen days, and voided ninety-one pints without losing weight. After what manner was the increase of gravity accomplished as regards the horse-riders? Whence did the discharged fluids come in the case of Mrs. Smith? From what source was derived the increase of urine in the diabetic individuals. The matter increasing the weight of the body in the one set of cases, and the accumulated fluids voided in the other, could not have been derived from the atmosphere or the earth by any mode we can conceive in our present state of knowledge. The foregoing facts point out to us, that we comprehend very little, if anything, as to the manner in which Nature effects most of the results transpiring throughout her economy.

(*h*) Dr. Buckland and other persons, buried some toads—confined in a box—deeply underneath the soil, and on digging them up years afterwards, found that these animals had increased in weight.

From whence did these reptiles get their sustenance during the long period they remained under the earth? There could have been no animal matter adjacent to their bodies, because the worms, snails, and insect grubs, &c., never go deeper than a few inches into or under the surface-mould, and if they did, they could not have entered the wooden compartment in which these batrachian reptiles were imprisoned.

(*i*) How do fishes grow in bulk, when developed from spawn placed in a fresh-made pond? There can be nothing in the water that we at present know of, which can cause the roe-eggs to enlarge before they are hatched, nor is there any food on which the young fry can feed* that could possibly be the source of the rapid growth and multiplication of these piscatory dwellers in the land-locked water.

To imagine that these animals increased in dimensions and number from the few flies they might have swallowed, would be as absurd as to affirm that a number of builders constructed a city with a few shavings and an ounce of brick-dust and mortar.

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* "Dog does not eat dog," nor do the same species of fish—as a rule—feed on each other.

(*j*) Under attacks of certain maladies an individual may be corpulent in the morning and almost a skeleton at night, as often seen in cholera and sometimes in small-pox, and at times in other diseases, as related by Dr. Gregory and various eminent physicians. Through what portals in these cases does the solid flesh escape in so short a period, and whence goes it, leaving no trace of its passage? Great eaters are often observed to be thin or of spare habit, especially children, as is known to many a mother. The reverse of this economy obtains with some persons, who, although they partake of little sustenance and work hard, become overburdened with obesity or fat.

(*k*) Clairvoyants affirm that only one-ninth of the components of our bodies is obtained or made up from the fluids and solids we swallow; the rest is materialised or created from and out of the unparticled or undeveloped and imponderable matter, diffused throughout the atmosphere and the regions of space. This latter pabulum, say they, is absorbed into the system by the skin, lining membrane of the lungs, and other tissues. The seers likewise state that the intestinal fæces are mostly a secretion of the bowels,* mixed up in a very minor degree with the fragments of the indigestible food we partake of. They also assert that the contents of the intestines are chiefly the result of the effete or exhausted materials thrown off after being employed in the economy of the system. These used-up substances pass into the bowels after the manner that the *palpable nourishment*, prepared from our *ingesta* is attracted out of or through the coats of the stomach to nourish or help to form the different organs of the body (independent of the absorbents and blood-vessels) by permeating their tissues after the process termed by botanists endosmose and exosmose, or penetrating and escaping through the pores which pervade all animate and inanimate substances.†

(*l*) When one of the jelly-like fish (*Medusæ*) has seized and swallowed some sea-animal, the prey so disposed of may be seen to dissolve and become diffused through the whole system of the captor. Sheep that feed on madder, have all their bones very rapidly stained by the colouring matter of this plant. Further, it is well known that after some chemicals and other preparations have been given to animals, that in a few minutes subsequently to the exhibition, the substances in question are found to have permeated the whole body, which circumstance can be proved by examining the blood, or a piece of the skin, of the creature under experiment. This transfusion

* The child in the womb eats no food, yet we find in the last bowel plenty of *meconium* (excrement), immediately after birth, which is equivalent to the fæces produced in the large intestine of ordinary or more mature individuals.

† See the Author's works on Homœopathy and Digestion.

is perfectly independent of the common circulation. We recall to memory a case that will illustrate animal endosmose and exosmose by the mere touch and even presence of certain objects. Some years ago, whilst attending on Sir Herbert Compton, who was the subject of general dropsy, I suggested that he should be mesmerised and that the limbs should also be rubbed to relieve his sufferings, and likewise the tense condition of the extremities. During the animal magnetism and friction, the arm of the mesmeriser always became astonishingly enlarged as if pervaded by some fluid. It was continually noticed that after the manipulation Sir Herbert Compton became greatly relieved and less bulky. Relative to the swelling in the magnetiser's arm, this result after a short time gradually disappeared, and its dispersion was much hastened by walking in the open air. Mr. Atkinson and Dr. Ashburner can attest to the facts of this case.

(*m*) The hydropaths afford us plenty of evidence that drugs, chemicals, and animal matters, under the water-treatment, find their way out of the body, through the pores of the skin, on or into the cloths or compresses and sheets in which they pack their patients. (See article "Hydropathy," in the Author's work on "Homœopathy," ss. 55, 67.)

35. It frequently appears to some of our senses, as before observed, that common ponderable matter, either in a solid or fluid state—like heat, light, electricity, occupies no *perceptible* space or locality that we can possibly comprehend. (See Section 20.)

Philosophers have propounded that two different solid bodies can not occupy the same space at the same time; but spiritual science reveals the fact that there is no such thing as a solid substance, all objects are dense but in seeming. In truth, viewed from this standpoint of real solidity, the elements composing the whole earth could be compressed, as suggested, by Sir I. Newton, into the space enclosed by a small room. Spiritual experience has also disclosed that as solidity is but a seeming, one so-called solid body can pass through or into another without injury to either. For instance—

(*a*) Anhydrous (waterless) salts, as before noticed (sec. 20), hold no apparent situation, when in solution as observed in dissolving burnt alum, &c., &c.

(*b*) Ten cubic inches of zinc and ten of copper combine as only ten of brass.—"Year Book of Facts," p. 443.

(*c*) A pint of spirits, or the same quantity of sulphuric acid, mixed with a pint of water, fall far short of making up the measure of a quart. The mixture of the cold fluids becomes very warm, as if the union of the liquids by condensation squeezed out heat, as pressure would the water from a wet sponge. A similar result—as regards

the evolvement of heat—is effected by the blacksmith, who by hammering a piece of cold iron—thus driving its molecules closer together—makes the metal incandescent, enabling him to light his fire. I could greatly multiply these examples; but the foregoing will perhaps suffice to convey to the reader the evidence of the fact in question.

36. I have, whilst inditing this article, asked many questions relative to the occasioners of particular natural events, and inquired repeatedly concerning certain incidents which are continually occurring around us, but we discover that the subject of causation is a very difficult skein to unravel; and we know by experience, that it is pervaded by a thousand entanglements, which lead and often mislead, out of one maze of perplexity into that of another. When we think that we are near the discovery of the source of this or that result, there is evolved some point or occurrence which destroys our preconceived opinions or the conclusions we expected to arrive at. Every effect that acts upon our numberless senses, is the result of a chain of causes. Had any one of the links of the chain or series been broken or interrupted, the result we experienced or witnessed would not have occurred.

37. Some of the foregoing circumstances serve to show, that distinct *particled*, also *unparticled* nondeveloped or the ultimate elements of unatomised matter, came and still comes, we know not from *whence*. It would appear to be continually arrested to combine here, and as frequently incited to go there, we know not *how*. In fact, generally it is impossible for us to trace the *where* it is tending to, or of *what* its innate qualities are capable of accomplishing, as it escapes out of one body and enters into or passes through that of another, or unites with this or that series, to form new associations. When we compare the phases of the molecules making up the masses of inorganic ponderable matter, with similar material atoms vitalised—as when combined with some living existence—how different are their bearings as regards constancy or stability of character, and especially must the variation exist or appear when we liken the corporeal particles of bodies with those spiritous material principles designated heat, electricity, magnetism, &c., given portions of which latter elements—so far as our present knowledge to display to the contrary extends—always remain the same as to general properties, but varying in intensity as regards their ability of motive action.

38. The above imponderable principles just named have no doubt certain distinct undulatory *forms* and qualities according to the bodies they pervade or are associated with, like musical notes, all of which latter have different *ellipsoid outlines* and *effective characters*, propor-

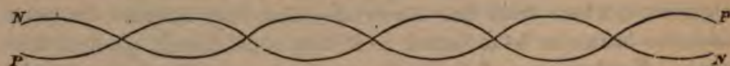
tioned to the number of the pulsations required to constitute each given melodious tone. (See article on "Sound.")

It might be admitted, with advantage perhaps to our subject, that these undulatory measured notes are composed or made up of a subtile imponderable material *essence*, which *affects* us under the form of what is commonly termed sound. This proposition being granted, we shall—with the reader's permission—look upon sound, as having a *permanent* being, resembling in tenuous character the spiritous matters of heat and electricity, and that it is diffused throughout our atmosphere, and most probably throughout all material existences. It will be found that *sound*, like ponderable matter, has a reactive quality and can rebound or be reflected back in a similiar manner to the thrown ball after striking against an object, as recognised in the echo. Light also, under certain circumstances, assumes the character of materiality, as shown by its capability of being reflected like sound; and further, it can be attracted, as shown by Faraday, who drew rays of light from their usual straight tendency, by means of electro-magnetism, which fluid was observed—when very intense—to cause luminous beams to be deflected, as if they were loosely pendent iron wires. Further, rays of light, like certain ponderable bodies, can be split or divided into distinct polarised beams, as when passing through particular crystals, &c. Professor Crookes has lately demonstrated that through the agency of light, he can induce motion in certain ponderable delicate substances, as suspended pith-balls, &c.

39. It is found that particular sonorous undulations capable of acting on our senses are called forth—as can be heat and electricity—by friction, percussion, &c. But be it observed that the blow and rubbing do not *create* sound, they merely unveil—so to speak—or set in vivid motion a certain *operative ethereal-like matter*, that produces the particular results which we term sound. This imponderable principle—under favourable circumstances—is also susceptible of assuming particular vibratory forms, as when generated or called into action by means of musical instruments. That different tones produce or carve out certain ellipsoid curves distinctive of the sounding note, was demonstrated by Chladni and others, in their experiments upon plates and membranes strewed with sand. Sound, then, we opine, must be considered as a *distinct efficacious something*, since it can shake a building, and the earth on which it stands, and can also appeal most positively to our feeling and sympathies; a *negative nothing* could not act upon a common material body, nor on our sense-receptive faculties. We cannot, nor shall we ever be able to originate any capable quality or *effective* existence. It has been demonstrated that a bell cannot ring in a vacuum; but in the experiment showing

this result, the matter of sound mixed up or contained in the air is extracted with the latter element, and of course there is nothing left to pulsate. No effects can be produced without appropriate *media*.

40. On further comparing sound with the imponderable material elements, we find that as magnetism, heat, and electricity are convertible the one into the other, so sound is capable of undergoing a change, enabling it to produce electric results, &c. It is therefore correlative, or has a reciprocal relation, and is susceptible of interchangement. That sound can produce electrical action, and electricity call into evident existence sound—is shown first by the fact that there is always a negative and positive stream of sound—undulations, passing in contrary directions along the pipes and chords of musical instruments when excited into action or played upon. These undulations may be readily detected by their forming nodes or intersections and bulging ellipsoids, which latter will be found to vary in length and width according to the note produced on the sounding strings, as illustrated by the following diagram.



That these sound-pulsations assume an electrical character may be shown by the divergence of the gold leaves on the approach of the electrometer to the vibrating strings. A similar result as to these nodes, &c., may be effected by directing a stream of galvanic electricity through or along the *wire* chords of a delicate musical instrument. This latter operation causes the string to vibrate (like the *friction* of the wind on the cords of the Æolian harp) and form similar elliptic curves and nodal points to the above, followed by the particular note of the chord thus acted upon. The nodes where the streams cross each other are readily detected by applying pieces of paper on different parts of the sounding string. Those placed over the nodes are observed to remain stationary, whilst the riders located between the nodes or points—that is in the centres of the ellipsoid spaces—are seen to tremble or be agitated. A blow, and especially friction, when applied to stringed instruments or pipes sets up an electrical action that calls sound into operation.

41. The matter of sound, like that of electricity, heat, &c., must form a part or be resident in all things, whether ponderable or imponderable, and not, as generally supposed, be the mere result of motion; nor can it be propagated or hastened by the property of elasticity, since, for instance, water—the most incompressible inelastic body in nature, transmits sound with four times the velocity and intensity of the atmosphere. Again, wood is found to be a more

efficient conductor than the air, insomuch as the scratching of a pin effected at one end of a piece of wood or stick of timber, is distinctly heard at the opposite extremity, though it is inaudible through the air only two or three feet from the operator.

Further, the matter constituting sound must extend into the ether or unparticled matter situated in the vast regions above the atmosphere surrounding the earth, since the bursting of meteors located many miles higher than our aërial element, gives rise to sound-waves, although the source of the sonorific agitations was situated in a latitude where there was no ponderable material to produce sonorous reaction. The conduction of sound and electricity, &c., through or upon lengthened bodies, may be compared to a chain of peas, extending through a long narrow tube, where, by agitating the first of the series, or forcing into the canula another pea, such action must cause vibrations in or eject the pea at the other extremity of the tube, and thus comes about the apparent rapid effects of communication from a distance. Sound can now be transmitted by electrical means through wires to almost any distance. Thus speeches, vocal and instrumental music, and even laughter, &c., have been instantaneously conveyed hundreds of miles in America by telephonic apparatus. (See Professor Bell, U.S., on the Telephone.)

42. *As regards heat*, I am constrained to observe, that up to the present period, our knowledge of this element has been very vague and imperfect. In fact all that we generally recognise as to its nature and condition, is its quantity and intensity.

I am here prompted to assert that there must be many kinds of heat, each dissimilar in quality and character, as there are a variety of metals and fluids, all of which latter are comprehended under the general terms metal and liquid. Heat, in this sense, may also be compared with colour, odour, and musical sounds. There are many classes of each of these, varying in their effects upon our sensibilities and perhaps—though hidden from us—on each other, and also upon their associations. This variety of quality must, I presume, likewise extend to the element of caloric. The belief in the existence of a dissimilarity in the heats appertaining to different bodies, suggests to us, that in coming time we shall be enabled to distinguish, measure, and separate different heats from each other, into a kind of scale, according to the effects they shall be capable of producing in the existences they may play upon or pervade, so as to render them recognisable to our senses, like the arrangement of musical notes. There was a time when melody was in as great a chaos—as far as our distinct appreciative faculties touching musical tones are concerned—as are at present the different presumed kinds of heat, magnetism,

and electricity. All that was known at one period relative to electricity was the result ensuing from the friction of a piece of amber upon certain cloths. Experience taught us that this resinous production would, after being rubbed, attract light bodies, as shown 2,000 years ago by Thales, one of the seven wise men. The celebrated traveller Humboldt speaks of similar results effected by the children of the South American Indians, on the banks of the Orinoko, from rubbing the seeds of a particular kind of rush upon some of their textile products. The seeds so treated were found to cause light cornhusks or filaments of cotton to adhere to them for a period. Our present knowledge of galvanism and magnetism is from recent experience. To the wife of Signor Galvani we owe the discovery of the former; and the latter, though recognised for many thousands of years, yet little was known or effected by it save that in ancient India the loadstone was resorted to, for healing certain maladies, and used in China as a land-guide by travellers, and more recently employed by the sailor to point out—by means of the compass—his course over the seas. But, how different at the present period is our experience of the potent endowments of the above elements. What a large portion of the Temple of Science is now dedicated to their productions, and for the display of their applications. So one day shall be exposed for the exercise of our senses certain instruments, by means of which we shall be enabled to display many separate divisions and capabilities belonging to the *different* kinds of heat, sound, colour, and odour, &c., which are now unknown. No doubt, as circumstances unfold to us the knowledge of the at present hidden things, so shall we be enabled to add other imponderables to the list of those already recognised. Relative to music, the ignorant savage knows nothing of the pleasure-exciting capabilities of the poetry of sound. His spirit is incapable, from lack of organic development and education, of comprehending the ravishing intoxication that pervades the musician, as he listens, spell-bound, to the melody and harmony that thrills through him, whilst exposed to the civilised experiences of vocal and orchestral performances. The savage is unconscious of anything belonging to the effects of sonorous cadences, beyond certain common results, which we might term noises; for instance—a party of Indian Chiefs, whilst staying in New York, one day entered a musical instrument-shop, to examine its contents. A gentleman present bethought himself that he would like to try which instrument would most attract the red man's attention. To accomplish this object, he first played slow and quick airs upon the pianoforte, and afterwards on the organ; this instrumental performer then solicited other musicians present, to execute certain short tunes on

the violin, bass, flute, &c. All these musical apparatus failed to arrest the attention of the Indians. But upon the gentleman who proposed the experimental test relative to the feelings of these aborigines, taking up and striking the triangle, the sound produced acted like a charm on these wild freemen of the woods, as shown by their all crowding round the performer, who was striking this jingling resonant piece of iron. This fact will, I think, illustrate the foregoing proposition. It was educated *genius* that invented musical instruments, which, after the employment of the human voice, enabled us to distinguish, teach, and appreciate melodious tones, with their differences and effects upon what the Germans designate the *nerf* or terminal loops of the phrenological organs of *Time* and *Tune* belonging to the brain.

43. It would appear, that after all our researches and discoveries touching caloric, that up to the present time, as before noticed, we can (polarisation, refraction, and magnetism excepted) only measure or distinguish one other positive quality of heat, namely its *intensity*, and this is effected through our feelings, and may also be marked or measured by means of the different kinds of thermometers now in use. I would remark that there is one fact, through which it may be suggested to us as a mode of personally distinguishing a difference in the quality of certain calidities or warmths.

Thus, if on rising from a chair after it has been heated by your own body you again sit in it, you will not detect or distinguish any difference in the temperature. On the contrary, if you place yourself on the seat recently vacated by another person, you will instantly become conscious of the prior occupier's animal heat, which may be congenial or otherwise. The above circumstance becomes especially evident to the more sensitive, after a chair has been sat in by certain persons, showing that the warmth and animal magnetism of distinct individuals are very dissimilar,* as likewise would be the sensation conveyed by the touch of their hands. In fact one person's animal heat—like their form or visage—may be agreeable, whilst another's temperature and temperament may create an opposite feeling, even extending to intense repugnance, similar to the effects experienced from particular odours and colours, which latter—as developed by the spectrum and certain photographic experiments—are no doubt made up of imponderable spiritous matters, like caloric and electricity. These sympathies and antipathies, belong also to animals, especially

* The heat in scarlet fever makes the fingers tingle after touching the patient, yet there is little difference by the thermometer between this heat and that of a healthy person.

marked out at times by the conduct of the domestic dog towards certain visitors. I have seen at different periods of my life—as have many other individuals accustomed to walk the woods and fields—even the wild birds and other creatures follow or approach at the solicitation of one man, as if by fascination, but keep at a long distance from another.

44. Further, relative to sympathies. It has often been noticed in telegraphy, that some of the correspondents can tell—especially the gentler sex—whose hand is conveying the message, and they can even frequently read by means of their feelings—without looking at the index-dial—some of the very words and sentences the messenger is sending; others have been known to return answers to questions, whilst sleeping at their post. These natural inherent abilities have been termed psychometrical, with which capacity some people are highly endowed, and others are apparently negative as to the exercise of this faculty or attribute.

45. It will be a most efficacious event and a wonderful accessory to science, when we shall have discovered the mode by which to display and use the numerous varieties of heat, electricity, and magnetism, which must exist in, or appertain to, the different minerals, vegetables, and animals everywhere surrounding us. I might here notice, relative to magnetism, that there was some years ago an instrument invented by a Mr. Rutter, of Brighton, which he called the magnetoscope. This apparatus, by its movements, measured and displayed the magnetic qualities, &c., &c., of all bodies, when placed in the disengaged hand of the manipulator of the machine, who could correctly name every object and its varieties without seeing them, if deposited in his palm. The distinct property appertaining to substances was especially developed through the agency of the hand belonging to certain persons. But as this apparatus could not be applied to science or the arts, at the present time, it was rejected (as were at one period the lightning-conductors, with many other discoveries), and being only regarded as a very *ingenious toy*, it has long since ceased to be exhibited.

46. From the continued crowding forth of new revealments, we feel conscious that the discovery must one day arrive, whereby we shall be able to recognise, arrange, and employ—as before suggested—the dissimilar heats, electricities, and magnetisms existing in Nature, as we do at present different odours, sounds, and colours, which last, by the bye, exist and can be detected independently of light, and are as tangible in the dark as any other existence, to those who have the phrenological organs large and active enough, and are endowed with sufficient and acute sensibility to appreciate them. This may be

readily witnessed in the somnambule and clairvoyant subjects. The latter can also detect sounds and colours when many miles distant from them.

Again: Thousands of blind persons have lived, and others still exist, who can by a natural capacity, feel and distinguish even the different shades in being among colours. Out of a number of examples as to this ability I select the following:—

Dr. Black, of Glasgow, relates of a Mr. Thompson (who lost his eyesight from small-pox at twenty months old) that he could impart all kinds of colours to every sort of cloth, and even the very shades of hues. He practised as a dyer for fifty-five years. The drysalter who supplied him with dye-stuffs was accustomed to state, that no man was a better judge of their qualities than Mr. Thompson. "I inquired," says Dr. Black, "how he was able to give lighter and darker shades to his goods; and how he was enabled to distinguish things that were clouded from those that were uniformly coloured." "That is more than I can tell," said Mr. T. I would here remark that had Dr. Black studied phrenology like his countrymen, Dr. Engledew, Dr. Elliotson, and others, he could at once have discovered the reason of Mr. Thompson's proficiency; namely, that he possessed large phrenological organs of Colour and other perceptive sensibilities.

In the Blind Asylum at Liverpool and other places, the sightless residents manufacture carpets, &c. Many of these inmates know well how to distinguish the different tints, without any assistance, so as never to commit an error as do colour-blind persons, who for other purposes can make good use of their eyes. Again: Among the basket makers of the Blind Asylum at Bristol, who construct ornamental baskets of different tinted materials, are found many individuals who can readily and correctly distinguish one shade from another.

47. As a contrast to the foregoing cases, I would draw attention to those persons who are minus the sense of detecting colours. These latter individuals are perfectly incapable of comprehending what is meant, when different tints are spoken of or pointed out to them. Some persons have this defect only in a degree, that is, they can often perceive one pigment or shade, but are incapable of distinguishing another. Many individuals can match or associate different colours correctly, whilst others have no perceptive feeling of this kind, on the contrary they are perfectly ignorant or unable to combine different hues, so as to make them harmonise. For instance; there lived a tailor at one time in Exeter, who was known to be very capable of measuring his customers and cutting out their clothes, but he could not, if he lost his mark, be left to select again the coloured pattern fixed upon by his employer. He was one day found mending

a black coat with a piece of brilliant scarlet cloth. This want of capacity in some individuals to recognise the different hues which things present to persons in general, often runs in families. Thus, the celebrated Dr. Dalton and his brother, as well as some of their relations, were colour-blind. On examining the eyes of these chromatically defective persons, the oculist, anatomist, and experimental philosopher can distinguish or discern no difference as to the quality and configuration in their visual organs, from those belonging to individuals who can readily detect all hues and shades. How different would have been the examination and conclusion of the phrenologist or clairvoyant. They would have experienced no difficulty, but at once have discovered that the colour-blind persons were deficient in the piece of brain devoted by Nature to the sense or receptivity of the spiritous rays appertaining to colours, which undulate from bodies at all times, whether in the dark or exposed to light. The appreciative quality of the existence of different pigments by the blind and clairvoyant, denote most positively that the eye is not always necessary to detect the various tints of objects.

48. The foregoing facts reveal to us that light, however vivid, is incapable of rendering the varied hues of surrounding objects evident to colour-blind individuals, and also point out that the spiritous chromatic material undulations thrown off from tinted matter find their way into the sensorium after a different mode to that commonly supposed. In fact the coloured rays act upon a certain portion of the brain after the manner of musical notes, by means of what the Germans—as before noticed—call nerf-loops, which are particular nervous fibres or filaments that become reflected on themselves, and appertain to each organ of the sensorium. It is along these nervous threads, apportioned or devoted to colour, that the tinted spiritous pulsations emanating from bodies are conveyed to the mind. Be it further recognised that these colour vibrations may be likened to the undulations of sound thrown into *form*, whilst passing along the strings and hollows of musical instruments when played upon, and like them they glide through or upon the nervous fibrillæ making up the organs which appreciate them. This appreciation is accomplished by the trembling of the fibres—as seen by clairvoyants—in sympathy with the colour vibrations, similar to the agitations of these filaments belonging to the phrenological organs of Melody and Time, when acted upon by pulsatory musical notes. These latter vibrations, thrown off by a sounding instrument, may be recognised by their affecting all adjacent musical apparatus, causing them to give off, or rather reflect and echo back, like notes, by the process of *reaction*, in answer to the impulsive impressions applied to them. This is caused by the un-

dulatory tones from the instrument first incited into action by the effort of the experimenter, to call forth this result.

49. It is only through the conducting fibrillæ of which brain-matter is made up, that we can become conscious of the existence of the things which encompass us, with their capacities and endowments. In other words, for persons defective in these nerve-threads (which if properly developed serve the purpose of conveying the qualities of their surroundings to the different organs of the brain, and through these latter to the mind) certain objects, or rather their qualities, have no existence in the world for them, whether it be a human passion, a substantive thing, or its simple endowments. It must be conceded, then, that the appreciation of every entity, whether organic or inorganic, with the elements which cause them to act and react on each other, must depend upon our being provided with a certain series of senses, the extent of which cannot be enumerated.

Our forefathers limited them to five, but five thousand perceptive feelings would not embrace all the distinct and particular points or *channels* through which the brain and soul receive intelligence of the presence, properties, and principles of the bodies surrounding them, to all of which they may be said to form a centre.

50. To recapitulate: It is only, then, through the qualities of bodies that we become conscious of their being. If in any way we are rendered incapable of appreciating the endowments of matter—which the perfect brain, when educated, so readily detects and sympathises with—of course the things from which the said qualities emanate have no entity, being, or existence for us. This fact has been exemplified in the before-mentioned colour-blindness, and may also be recognised when suffering from recent catarrh, or cold in the head, as it is commonly termed. Thus, if the nervous fibrillæ belonging to the organ which appreciates odours or effluvia be disturbed, deadened, or destroyed, then, though we may be exposed to the most pugent fumes or offensive exhalations, we do not—in fact we cannot—detect them; further, we fail even to announce the kind of beverage put into the mouth, when the nose is firmly compressed. Again: No person can appreciate that poetry of sound termed musical notes, by or through the ear, however acute or delicate his auditory abilities may be. If an individual is without those brain developments termed by phrenologists Melody and Time, harmony cannot exist for him. I have known certain individuals who could never distinguish one tune or its time from another. The grave and lively air, slow or quick movement, were the same to them. The persons in question were conscious, as they expressed it, of a variety of sounds—or to them, noises—but they had no conception, or rather *feeling* of what

was meant by musical intonations. I well remember the Rev. Dr. Davis, of Rockhampton, Gloucestershire, who, when challenged to name a certain air, when one day listening to a merry country dance executed by Dr. Jenner's daughter, he exclaimed emphatically, "Ah, now I do know that tune; you are playing 'God save the King.'"

51. In again referring to the organ of sight, I would observe that the eyes are *only* employed or *made use of by us* who have our vision in the presence of light, and for this reason:—Luminous rays enhance or increase immensely the *intensity* of the undulatory properties of bodies, as shown by its greatly augmenting the vibratory attractive qualities of the loadstone. It is through this redoubled action of the undulatory qualities of matter, under the influence of the element of light, that we, in our common or general state, are made sensible of the existence of things. Another reason why we cannot in our normal condition perceive substances in the dark, is from *habit*. That is to say, unless the radiations, or undulations of the characteristic qualities of bodies are of a certain or sufficient vividness, we from custom or general education, as to these pulsatory emanations from our surroundings, do not feel or notice the objects which encompass us, when all the luminous rays playing upon them are intercepted. It is, I repeat, these luminous rays which give to the molecular undulations of bodies the requisite intensity necessary to enable us to perceive the objects by means of our general receptive sensibilities, and not, as supposed, by means of the eyes.—(See "Colour Blindness," sec. 117.)

In addition: The failure to perceive in the dark—through our feelings—the continuous undulatory properties of objects, is owing to the extreme delicacy or faint impressions these qualities make upon us when they are not stimulated by light. Persons who have long been blind, become more sensitive to external impressions, and from education or acquired habit, which has been called second nature, they do not need so much the intensity of the pulsatory emanations from bodies, to arouse into action their appreciative feelings so as to enable them to recognise the existence of things. I have read of many blind persons, and seen some, who could—especially at certain periods—feel and distinguish, like somnambules or clairvoyants, the properties of objects, as well or better in the dark, than many persons with their perfect sight can or do in the presence of light.

As regards the opinions of ancients relative to the undulatory theory, I quote the following:—

"Epicurus (born 342 B.C.) supposed that bodies are continually sending off from their surfaces slender films or spectra of such subtilty, that they easily penetrate through the senses to the brain;

but before Epicurus, PLATO (born 430 B.C) conceived that we saw the shadows of things and not the objects themselves and his pupil ARISTOTLE (born 384 B.C.) taught that as the senses cannot receive material objects themselves, they take in their images. DEMOCRATES (born 460 B.C.) insisted that perception was the result of the impressions made on the organs of sense by images, which constantly emanated from bodies, and varied according to the formation of their originals. LUCRETIUS (born 95 B.C.) suggested the theory that the superficial surfaces of all bodies were continually flying off. Dr. Briggs (Newton's instructor in anatomy) maintained that the nerves operate by vibrations, like musical chords, and thus conduct impressions to the brain. It is by means of molecular undulations that bodies engrave or picture themselves on the different surfaces employed to produce their representations in the process of Daguerreotyping. These latter results can be produced in the dark or shut up in a box, only that it requires a longer period to effect the object."*

52. In addition, I would ask what is ponderable or gravitating matter? What are its offices in the economy of Nature? Considered abstractedly, its character is a very negative one, and as far as our present knowledge extends, it must be looked upon merely as the instrumental servant, or rather as an agent, performing the part of a lever. It is by means of this said leverage, that the spiritous and spiritual essences appertaining to the universe work out all the circumstances and events which occur throughout the world's natural system of motion, or in the exercise of the mechanical arts. Moreover, without the intervention of the spiritous imponderable elements, substantive gravitating matter could never have appealed to any one of our senses.

53. The ordinary world is led to think more of crude quantity, than *effective* quality, never dreaming that inanimate or lifeless matter is perfectly negative, as far as action and reaction are concerned, in the varied results worked out in its appliances as regards the arts. The numberless changes continually ensuing in the routine of Nature, as she develops the vast products which surround us, owe their origin to agents unrecognised or not noticed by the common or general observer. Most persons are totally unconscious that it is the *ever motive* imponderable and imperishable spiritous essences or principles pervading Nature under the form of electricity, magnetism, heat, &c., that exercise their dynamic qualitative energies or abilities upon gravitating material bodies, and which effect all the work and results we wit-

* See the Author's work on "Will-Ability," p. 12, note.

ness taking place around us. The growth of vegetation ensues through the ruling action of the foregoing agents of mobility, which, with the nddition of effective motory exciting light, give rise, in land plants, to the first stage or state of vitality. In the animal economy, accompanying the above imponderable elements, will be found added the primary form of *spirit-matter*, commonly termed the vital motive principle of living creatures. But appertaining to the human being, in addition to these able motor elements, and vital impulsive energies, is superposed a *supreme spiritual and progressive reasoning essence* designated the human SOUL by means of which the will-ability and the pre-eminent thinking faculties of man are exercised.

54. I am here induced to propose or assume that the foregoing motive agents have appertaining to them distinct material bearings, since through their operations alone all the changes occurring among the things around us are effected. Besides the human mind refuses to entertain the idea of a *nothingness*, being capable of working out natural and mechanical results. In accordance with the foregoing I shall venture—by way of understanding more positively or substantively the qualitative character of the above-named subtle existences—to look on them as Nature's cause, producing corporeal effects, or as a series of spirito-material principles, and in alluding to them in this sense, they might, I think, be designated as follows:—1st, electro-fluid matter; 2nd, polar magnetic matter; 3rd, luminous matter; 4th, calorific matter, sonorous matter, &c.

In like manner I would include the vital principles of the vegetable and animal kingdoms under the generic term of Life-matter; the climax to the foregoing would of course be the all-comprehending or reasoning spiritual body—SOUL-MATTER. Relative to the materiality of light, this property was apparently proved—as before noticed—by Faraday—who, by means of electro-magnetism, deflected luminous rays, as a loadstone would have attracted a piece of steel or a bundle of iron wires. Again: As to the materiality of the electric fluid, Mr. Lake, of the Laboratory, Portsmouth, proved that electric matter is really a fluid, and when collected, so as not to exert its ability of attraction and repulsion, it obeys the law of gravitation like gases. The developed electric fluid was received into a Leyden-jar insulated on a glass plate. On the side of the jar near the bottom was a star-shaped crack, from around which the metallic coating was removed. On charging the phial, it was observed that the electric fluid soon began to flow out in a stream from this opening, and on continuing the working of the machine, it flowed over the lip of the jar descending in a faintly luminous conical stream—visible only in the dark—until it reached the level of the outside coating, over which it

became gradually diffused, forming as it were a frill or collar. When the jar was inclined a little on one side, there was a perceptible difference in the time of its escape over the higher and lower part of the lip, from the latter of which it began to flow first. On discontinuing the working of the machine, the liquid first ceased to flow at the lip of the jar, and then at the lower aperture. On renewing the the operation, it first re-appeared at the lower opening, and afterwards at the mouth. In addition: The ability of carrying—by means of a sphere or ball—distinct portions of electricity derived from the surface of an electrophorus, and the being capable of delivering these said segments to a third body, proves that the electric fluid is a material *something*, for it must be conceded by every one, that it would be impossible to divide a nothing into parts.

55. But to resume. Crude and lifeless matter, likewise the fabricated mechanical frames of things, also the stems of plants, the bases of zoophytes, and lastly the bones of locomotive animals, merely serve as so many supports or fulcra* by means of which the varied and all-effective imponderable elements display their abilities or energies, making use of these different supports to work out many of the numerous effects of which our senses take cognizance.

Moreover, it is the life-principle appertaining to animals, that enables them to accomplish locomotion, by inciting their muscular system to employ—as so many levers—the different parts of the bony skeleton belonging to one set of animals, and the supporting structure—as with the crustacea—possessed by others. It is the heat and electricity eliminated during the union of the carbon of the coal and the oxygen of the air, in the fire underneath the boiler, that produces the steam, in which is contained the dynamic heat and electricity that sets the levers of the engine in motion, which in turn act on certain parts of the machinery, as in the drawing or driving along the railroad car, &c., &c. That this steam contains vast quantities of electricity—independent of friction, which cannot *create* this fluid—is shown by our being capable of charging twenty large Leyden phials in a few seconds, whilst the steam is escaping from the boiler, through certain small tubes made of partridge-wood, connected with the conductor of a hydro-electric machine, like the one at the Polytechnic Institution. This presence of electricity in steam, was first discovered by an engine-man at Sedgehill, near Newcastle, who, when passing his hand through the vapour escaping by a fissure in the boiler of a locomotive, received an intense electric spark, which he spoke of as being like flashes of fire. When the balls discharged

* Fulcrum—the point around which a lever moves.

from Parkin's steam-gun struck the target in the dark, there was always a discharge of a flash of electrical light after the percussion of each missile.

It should be remembered that water is a combination of the protoxide of hydrogen, heat, and electricity. By abstracting portions of the two latter principles, ice is formed; by adding very large quantities of these last-named elements to water, we produce steam, with its all-effective energies or dynamic abilities.

56. In addition to the foregoing I might also notice that the motive ability of some animals likewise ensues through the action resulting from the *formation*—or according to the Schools, burning—of carbon in the mucous membranes and external skin, which two tissues are in opposite electrical states. This process of natural combustion, in one way eliminates or rouses into effective operation, the vital electro-magnetism pervading most organised bodies. This living electro-magnetic fluid—as regards the higher order of animals—acts upon or stimulates the muscles, causing them, assisted by the nervous principle, to employ (directed in man by the soul's will-ability) as before noticed, the movable bones, like so many helping implements or apparatus, and thus comes about the capability of muscular exertion. It is man's spirit, or his soul-element, which enables him to lift a weight from the earth, through the means of the hand and arm, and also renders him capable of displacing a given mass, through the agency of his limbs with the help of the crow-bar. It is not the members of the body or the instrumental levers that achieve the feat. They are merely agents by and through which the inner selfhood effected its purpose.

57. The hands of a clock cannot be impelled to move by *self-acting* machinery; they are caused or incited to continue their progress round the dial through the agency of electro-magnetism, as by that from the earth, commonly called the attraction of gravitation; this energetic principle acts on the weights, and these latter—through their attached chains or cords—operate on the works. Note also that the pendulum and balance-wheel of time-measures are induced (through the appendages attached to the clock-strings, and the reaction of the spring connected with the apparatus of the watch) to vibrate synchronously with that great time-keeper—the globe we inhabit; for if we interfere with the earth's action by an artificial magnet, we can stop the balance-wheel of the watch, by paralysing or interfering with the reaction of the spring, which experiment by the bye often ruins the chronometer and prevents its being again influenced by the earth. In continuation; we can also bring the pendulum of the clock to a state of rest, by attracting upwards its weights, when made of iron, with a sufficiently large loadstone or magneto-electric battery. It may be likewise

noticed, that we can cause the said pendulum to resume and continue its vibrations without the weights—*after giving it an impetus*—by connecting the works of the time-keeper with the earth, through means of two wires, the one joined to the positive plate of zinc, and the other to the negative sheet of copper, both plates being separately inserted into fresh-made ground.

I would remind our readers, that it was through the agency of spiritual-materiality—the human soul—that the watch and clock were first incited into effective motion, for without this pent-up, so to speak, quality or ability expended by what has been commonly termed the incorporeal part of man, in winding-up these chronometrical instruments, they would have been for ever still, and incapable of pointing out the lapse of time.

58. Note also that the electricity pervading the storm-cloud is not a body capable of giving the slightest sensation of weight; yet in its effective capability, this imponderable element, when acting upon what is commonly termed material objects, and meeting with *resistance* to its course through non-conductors, we find it equal to the splitting of the sturdy oak, crumbling the massive building, and rending the firm solid earth, when brought into dynamic action by disturbing agents, as where the different forms of the electric fluids act and re-act on each other, negatively and positively, and thus become thrown into opposite states of effective abilities.

59. To further illustrate the great operative capacity of another of these spirito-material essences, I would point to the mighty influence, which the magnetic fluid-element exerts over the planet we inhabit. It has been recognised that the earth, from its intense *innate* propensity, to be in motion,* turns upon its axis, and would, it is known, also progress onwards for ever, in a straight line, but for the action of certain attractive magnetic gyratory rays which extend between it and our solar luminary. These attractive streams serve like so many check-chains to guide our planet through its destined course round the sun, as the boy holds the swinging ball encircling his person by a string attached to it; so that the earth's vehement disposition to continue onwards in a direct line is overcome and exactly balanced by the attractive magnetic cord-like waves appertaining to our light-exciting orb of day. These magnetic gyratory threads maintain the largest and most distant systems true to their orbital course.

The *quantity* of these undulatory magnetic cords extending between or given off from bodies is the same, according to the

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* See the Author's Essay on Motion.

magnitude and quality of the masses of the matter whence they emanate, whether these substances lie close together or are millions of miles apart; but not so the *intensity* of the pulsatory emanations; their energy increases in the ratio of the approximation of one object towards another.

60. *As regards Attraction and Repulsion.*—It might be desirable, perhaps, to illustrate for the advantage of the general reader, one of the probable reasons why the two north and the two south ends of elongated magnets repel or fly off from each other when they are approximated; also why the north and south poles of two distinct oblong loadstones approach or are attracted together, when sufficiently near to be effectually—from increased intensity—under the influence of each other, or within striking distance, as it has been sometimes termed.

It is a well-known fact that certain persons, in their normal condition, are capable of distinguishing in a dark and sometimes in a lighted room, definite, luminous undulations, bursting out from the two extremities of the common bar-magnet. It has also been affirmed by the parties in question that these—as it were—phosphorescent magnetic rays or undulations turn spirally on themselves, like revolving corkscrews. This quality belonging to these polar waves explains why the north and south ends of elongated magnets fly towards each other when approximated. The magnetic undulatory beams, escaping from the dissimilar polar extremities of a bar-magnet, revolve contrary ways, viz., one set turning to the right, the other series to the left. Thus, when these spirally rotating rays meet, they wind round or within each other, and of course the diverse ends of the magnets become approximated. The opposite action to this ensues, when two negative or two positive poles approach each other. These different or opposite results of approach or recession ensue after the manner of a screw-pin playing in its properly fitting nut or matrix, which, accordingly as they are turned to the right or to the left, retreat from or approximate each other.

61. *Touching the capacity denominated Force and Power.*—The qualities or abilities commonly designated Power and Force by the Schools are mere words, and, as at present employed, do not teach or explain any one thing, nor do they point out, in the slightest degree, determinate causes. I shall therefore be led to recognise the results effected in Nature and through art — usually so vaguely accounted for—as springing from the action and re-action of certain spiritous matters, as heat, electricity, magnetism, &c., &c. I shall also consider that the so-called *vital forces* proceed from the operation of the primary spirito-vital principle found in the vegetable and lower

animal kingdoms, which effective element finally culminates in the soul of man and causes him—in addition to employing the vegetable vitality and the abilities of the common animal—to exercise mind-energy and its pre-eminent will-capacity.—(See article "Cause and Effect.")

62. I am here led to suggest that, as the spiritous matters, heat, electricity, and magnetism, &c., are supposed to be reciprocal—that is, interchangeable the one into the other, as presumed in our philosophical investigations—so, by analogy, it may be conjectured that particular kinds of ponderable matter, under certain forms and conditions, are also transposable. The ancient alchemists taught in their schools, that the transmutation (change into another substance) of the metals was an established fact.

It is most probable, that if we could lift higher the veil which hides the economy and processes worked out by Nature's laws and capabilities, it would be revealed to us that transmutation is possible in her laboratory, of all bodies, by a process, at present hidden from us, of dematerialisation and recomposition of simple as well as compound things, out of unparticled or undeveloped—that is, the ultimate—elements of materiality; and by certain unfolding circumstances I am urged to affirm that it is actually a fact that is constantly taking place among vital existences, and also in particular localities, under definite phases of operation.

From the foregoing we may perhaps assume that the spiritous matters, heat, electricity, &c., are capable, under certain conditions, of being changed, or progressing onwards, into the incipient life-principle of the plant; and, again, this high endowment of the vegetable world may be transposable or promotable into the vital capacities of animals; and we may further venture to aver that both these latter energies are susceptible of growing into or forming the terminal result of Nature's culminating efforts, the formation of the spiritual, reasoning, human soul.

It must not be forgotten that every process appertaining to the unfolding of the productions of the universe is *progressive*. This being the case, all material evolutions and those essences which have once been vitalised and spiritualised can never revert or change into any existence inferior in being, either as to property or capability.

63. Each distinct natural production and every entity we can conceive belonging to living nature, commenced from a *quickening point of energy*. Thus it was a minute magnetic *spiritous nucleus* of inciting vigour, which drew around it certain material molecules that commenced, and ultimately developed the crystal and some other mineral productions.

Further. It was a distinct particular *electric-vitalising point* of attractive action that gave rise to the blastematous-germ or bladder-speck, which produced the plumula (the stem-rudiment in the embryo) that originated the living plant. Again: It was a species of *vivifying essence-focus* that brought together the compounds giving rise to the sperm and germ-cell from which was evolved the life-principle, endowing animals with their many capable propensities. Finally, the culminating *attractive centre* of all existences is the direct *spiritual pivot* that draws or brings around it, out of Nature's most refined elements, the sublimated principles which constitute the human soul.

These different capable spiritous, vital, and spiritual adductive centres or *points d'appui*, then, invite or attract towards themselves certain subtle undeveloped or ultimate material elements, we at present wot not of, which create or call into being the crystal and the rock, the plant and its flower, the tree of the forest and the shrub of the valley; and, likewise, every species of the animal world and its climax—the profound reasoning man.

Every distinct living thing, whether animal or vegetable, originally commenced its being from an egg or its representative—the ovoid vesicle. The far-seeing and deep-thinking Brahmin answered correctly, when replying to the query, "Was it the bird or the egg that first made its appearance?" stated that it was a quickening point of spiritous or spiritual energy that gave rise to the ovoid form out of which first emanated all vital existences, and these, once formed, eternally progress onwards, for as the bird can never return back into the egg, nor the oak into the acorn, so no vitalised object can repeat itself.

I would here call the attention of the reader to the fact that the compound constituents of which the vegetable kingdom is composed do not in any way exist ready formed or prepared for adaptation, as is generally supposed, neither in the air, the earth, or its waters, but they are developed from certain subtle unparticled or unatomised elements at present unknown to us, or at least not demonstrable to our senses which are attracted towards the adductive centre of growth situated in the plant or tree, and these alone tend to their unfolding economy.

Further. The development and augmentation of the animal takes place, especially in the lower order of living creatures, as the zoophytes, more from the ethereal or tenuous amorphous elements they attract into themselves through their surfaces than from what they eat and drink, as before suggested and demonstrated.

64. But to resume. Figuratively speaking, says Hudson Tuttle, massed molecular ponderable matter is for ever living and for ever

dying. It lives or exists in form, as long as attraction prevails over repulsion. It commences to alter or die, relatively, from the moment that repulsion prevails over attraction, and death with the vitalised mould or shape "is the closing up of the account, the end of the great struggle." The negative or amorphous imponderable atoms thus let loose are then gathered up, perhaps by fresh elements of qualitative ability, and re-created—so to speak—into some other existence.

65. Matter, though ever changing, will have its *final purposed* form conserved in the hereafter or the spiritual world. No effect or result can ever perish. All that has ever been thought, sighed, or said, done or produced, will be indelibly engraved or pictured upon the atomised and spiritous surroundings of every past occurrence, and these shadows or impressions can be and have been read and pointed out through psychometry by the spirit of the clairvoyant here, and will be accomplished most pre-eminently in a future state after the soul has been liberated from its earthly tenement.

66. Such are the bearings of matter; such is the history of the constituents of this planet. The dissolution of every series of the generation of material things has assisted, I reiterate, to form or give birth to a spiritual world. Nothing that has ever had life perishes, their images can and will be recalled in that other state of being to which we are all tending and every association remembered by those who have the purpose so to do. What to us appears an imaginary shadow here will be, in a future existence, a vivid reality.

Every thought of ancient times, the most remote inspirations and prophecies, have left their indelible impressions upon the mind of ages. No idea ever vibrated through the inner selfhood of man that is not recorded in some strata of spiritual thought, to meet him face to face on awakening from the sleep of death into the world of spirits.

67. Many theologians think of matter as something *tangible* and spirit as an existence perfectly *intangible*. The fact is, that which has been called matter can only be revealed to our senses by the resistance we experience through the action of spiritous and spiritual materiality. But it may be in truth announced that the eye never saw, neither did the hand ever touch, nor the tongue taste, that which is commonly called gravitating matter. It is the emanating qualities bursting out of the so-called tangible and visible arrangements of the ultimate elements of matter into *form* that affect our senses, and *not*, as supposed, the material substances themselves.

68. It is by the attraction of Nature's imponderable spirito-magnetic fluids pervading the earth, that different substances are capable of giving us the idea of *weight* and *opposition* to our efforts

when displacing them from the localities they may at any time occupy. Again: It is a magnetic polar attraction which keeps molecular atoms of bodies together, or rather, in apposition. Were their chemical elective affinities overcome, as is the case with those free corpuscles, making up the chief elements of the air breathed by us, we should not know (things being comparatively at rest) of the existence of these said liberated atoms, unless their component particles were put in motion by some spiritous-matter, viz., heat, electricity, &c., as is the case with our atmosphere, which is only perceived whilst the wind is blowing; this motion (*almost* alone) in a general way reveals to us the existence of the aërial element that envelopes the earth.

69. It may be said that there are at present known to us in Nature, three characteristic and distinct classes of material bodies. The *ponderable*, the *spiritous*,* and the *spiritual*.† First. *Gravitating matter* is demonstrable to us through particular and distinct properties, which can only be made evident to our feelings by means—secondly—of certain undulatory *spiritous-elements*, as heat, electricity, and magnetism, &c. Lastly, and specially, must be recognised the *spiritual-material essences* discerned by particular animal functions, as perceived and felt in still and locomotive life, to which latter must be added other qualities or capacities super-eminently developed in and appertaining to the inner selfhood of man.

70. I will conclude this part of my subject by suggesting that gravitating matter is made use of as the mould of the *life-principle* of vitalised beings, as well as constituting the formation of inanimate substances. Spiritual-matter is the moving ability belonging to vivified bodies, and gives existence to the highest reasoning capacity possessed by man. (See the Author's Essay on Motion).

71. "Matter," suggests Hudson Tuttle, "has been resolved into various primary bases. First, it existed as a fire-mist, then as a heterogeneous ocean, which finally separated into the yielding water and the earliest conglomerate rocks. The latter in time crumbling into dust, produced the soil, from which emerged the vegetable world. Out of this botanic kingdom gradually progressed the lower forms of animal life, and these proceeding onwards through untold ages, grew into the higher productions of animated nature and humanity." Thus all things are found in man: he himself is an epitome of the universe. Science is demonstrating that there is a refined ethereal element which penetrates all bodies with its requisite *vibrating motions*."

72. The spiritual body of man is built up of certain subtile elements

* Spiritous—that is, active, refined, ardent, as relating to electricity, heat, &c.

† Spiritual—mental, intellectual, purified from external things, and appertains to the mind, spirit, or soul.

appertaining to the general system of entities. The soul-principle, then, of the human race, holds to its place in the existence of things, and being a part of the divine element of Nature, it must be immortal.

Ascend the stream of time as far as we may, new formations will be found at every step, but creation, or the fresh generation of imponderable matter, and its associated spirit-essences—never. The old system always contains the germ of the new.

73. It is generally stated that the soul is "the intelligent, immaterial, and immortal part of human beings."

How can an immaterial* being have intelligence? How can it exist? It is an absolute nothing, an intelligent nullity, and an immortal naught! And this nothingness is not a fact of organisation, but a gift of the Deity! Ardent indeed is the imagination of the metaphysician † who accepts such an existence and maintains its desirability. This immortal part, they say, is a fragment from the divine Being, and is an image of Him in quality, but different in degree.

Not a step has been made in this path since the Brahmins of the Ganges taught their doctrines, which are so remote that all historic dates are, compared to them, as occurrences of yesterday.

74. "If we could return back along Time's path far enough, we should find that some of the constituents of the earth were thrown off from its central sun by radiation or magnetic and electric action, which in time became a liquid ball, and by further emanations, a crust cooled over the perhaps intensely heated and condensing fluid centre. The then atmosphere may be conjectured to have been black with the vapour of volatilised elements, which were probably too intensely heated to unite in compounds, and not until the temperature became lowered did oxygen and hydrogen, or their ultimate and *unparticled elements*, unite to form the vapour of water. When this temperature was still further reduced, the vapour condensed and fell in showers on the heated surface. Then began a new series of action, which for awful sublimity could only be witnessed in the primeval state of worlds. The water falling from the murky atmosphere, surcharged with volatile elements, ran down into the hollows of the rocks, penetrating the crevices, and, coming in contact with the internal heat, became converted into steam, and in this state rending the surface into fragments, which afterwards became disintegrated and pulverised. Collecting in large volumes, thermal lakes and seas

* Immaterial.—This word is derived from the French *immatériel*, and has been translated as that which consists neither of matter nor body.

† One who soars beyond the bounds of actual experience.

were formed, which boiled, cauldron-like, sending up steam and spray, and thus confusion prevailed. Land and water intermingled; the sea being an archipelago of thickly interspersed islands of rugged rocks; the low, irregular peaks scarcely appeared above the black waves, and their rugged sides spoke of their fiery birth; the weird landscape of desolation was enveloped with a black and lowering atmosphere in which the storm never ceased. Nature put on a strange garb in those her early days, yet order's laws reigned supreme amid the wild confusion. Even then the vast plan of Nature in all her minutiæ was written in the secret chambers of the constitution of the atom, and this commotion was only its throes and spasms to give it more complete expression."

75. And now touching the matter of the soul. As the mortal senses cannot recognise the matter or substance of which the spirit organism is composed, and as all idea of matter is derived from them, we cannot form a just conception of its qualities, nor know little more than that it must be subtile in character. In fact the spirit must be formed of matter, and become refined and sublimated perhaps, but matter still.

"Science deals mostly with visible materiality,—that extreme of entity which is palpable to the senses, and has *density* or *form*. The Harmonial Philosophy of the modern explorer deals with the same matter in a vastly different mode: the opposite extreme of the same entity, matter in its translated or ascended condition, a position advanced above the molecular or atomic state, in short it treats upon *undeveloped and unparticled* as the ultimate elements of matter. Scientific investigators fail to get out of or beyond *massed or the molecular phases of materiality*; they rarely touch atoms, never essences."

76. We are often met with an objection urged as conclusive. Thus, if spirits say they are material, why can we not see them? But experience teaches us that the atmosphere cannot be seen, and if we trusted to the eye alone, should never know that it exists. Whether a body is visible or invisible to us in our present or *common* state, depends mostly on its relation to light. Professor Grove most particularly insists, "that the energy emitted from the sun may take different characters at the surface of each planet, and require particular organisms or senses for its appreciation. Myriads of organised beings may exist, imperceptible to our vision, even if we were among them, and we might be invisible to them."

77. "The necessity of ascending to higher elemental forms should be apparent, and the individualisation in the spirit is effected by and through means of the mortal body. With the proper understanding of words, we may employ the terms, 'matter' and 'spirit;' the

latter meaning the subtile and ultimated elements which pervade and underlie the physical world. From the former the physical body is fashioned, from the latter the spiritual body. This dual development commences with the dawn of being, and is common to all living forms. The two mature together, one pervading and being an exact copy of the other, and death is their final separation. The mortal body is the form by which the immortal is created or collected."

78. As the animal emerges through intermediate shapes of development up or into man, and the infant knows less than the perfect animal, the line of demarcation between the perishable and imperishable is apparently drawn with difficulty. However a certain degree of advancement is essential, beyond which immortality obtains. The line is not abruptly or prominently drawn.

79. "The spirit of an animal is not perhaps necessarily immortal, but can become gradually extinguished after an indefinite time. As the constituents of the creature's body are absorbed by wind and wave, and wafted around the world, to be seized with avidity and decomposed by other forms of life, so its spiritual portion is resolved like a cloud into the ocean of spiritual elements."

80. Immortality is conferred on the human race as the highest aim of creative energy. Man's spiritual state must surpass his mortal, which is its prototype, extending and consummating a mortal life. Whether we die drawing our first-breath or after a full century, has not the least influence in the *final* growth and attainment of the spirit, which embodies every law of progress; whether as a spirit clad in flesh, or a soul in the angel spheres, man is amenable to the *same laws*. We can learn many lessons from the contemplation of this fact. By it we comprehend our duty to laws, and our relations to higher orders of intelligence. The brutes of the field and also our ignoble brethren—all the forms of life beneath us—require our kindness, love, and sympathy; the angels of light—our elder brothers—call forth our love and emulation. We are ephemeral, of a day, but companions of suns and worlds, and possessed of a proud consciousness that when the lofty mountain-peaks have become valleys and the earth, as now constituted, has passed away, when the sun no longer shines or excites forth light, and the stars of heaven are lost in night, *our spiritual being, in its course towards perfection, will have but begun, as it were, its never-ending circuit.*

81. Man, subject to certain excitations or affections of his senses, is led to assign those dispositions to an external cause. This outer effect is that which he calls matter. What the material world is in itself he knows not. He recognises only its capability of producing in him certain impressions—the ordinary feelings of the senses,

sensations as they are called—and those which give the ideas of extension, figure, and resistance. Thus, having already supposed a something without, he pronounces these to be its qualities, ignorant all the while what that something is, and knowing it only as the *substratum* of the qualities. We weigh matter, measure and decompose it, &c., and if we seek to advance one step beyond these gross operations we find ourselves helpless, and before us an immeasurable abyss.

82. All differences in material objects as they exist in Nature have been *said* to be the effects of motion disposing primary particles into *forms;* and that which is called chemical action is—when considered in its origin—nothing more than an effect of mobility in the more refined and subtile order of substances; *decomposition* being produced by opposing abilities, composition by attractive energies; and thus also chemical action, like that which is called mechanical, is resolvable into an effect of motion. We know nothing, then, of matter, save through its sensible properties: remove *these* from a body and the idea of its existence disappears.

83. Corporeal substances have been supposed to be made up of particles or atoms having particular forms, each possessed of a certain magnitude or property, and that determinate numbers of atoms of one kind admit of combination with a limited number of another genus or of several species, and thereby form by their union *compound* atoms, having properties belonging to that commixture differing from the known qualities of their elemental particles or those separate molecules of which the compound is formed. As, for example, water—a fluid—consists of compound corpuscles, which when separated into its constituents is found to be made of gases—viz., oxygen and hydrogen.

84. Some schoolmen have assigned to matter primary and secondary properties.

Primary Qualities.—Length, impenetrability, depth, indestructibility, breadth, divisibility, weight, inertia, porosity (this latter being shown by the interstitial spaces between the atoms of substances which is occupied by heat), ether, light, electricity, and unparticled or unatomised matter).

85. Secondary Properties.—Density, transparency, opacity, translucency, malleability, solidity, ductility, colour, fluidity, and all those qualities by which we distinguish one substance from another.

Certain *literati* have defined matter as anything which occupies space, and to be subjected to attractive and repulsory laws. The attractive are divided into those that act at sensible and insensible distances; the repulsory into homogeneous and heterogeneous, namely, those which take place between similar and dissimilar bodies.

PART II.] JULY, 1879. [PRICE SIXPENCE.

NEW VIEWS

OF

MATTER, LIFE, MOTION,

AND

RESISTANCE:

ALSO

AN ENQUIRY INTO THE MATERIALITY

OF

ELECTRICITY, HEAT, LIGHT, COLOURS, AND SOUND.

To be Published Monthly.

BY

JOSEPH HANDS, M.R.C.S., &c., &c.,

Author of "Will-Ability," "Beauty and the Laws Governing its Development," "Homœopathy contrasted with Allopathy," "A Dissertation on Diets and Digestion," &c., &c.

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PRELIMINARY REMARKS.

It is intended throughout the forthcoming work to point out certain novel characters in regard to the influencing attributes of Matter—by displaying through particular facts—the true agency that the atomized and unatomized or ultragaseous worlds, exercise in the economy of Nature. Added to which, will be an investigation into some of the more abstruse Laws governing the various kinds of Motivity. Also an inquiry touching the action of the Life-Principle as it manifests itself, whilst governing the development of the vegetable and animal kingdoms. Further, the Materiality of Electricity, Heat, Light, Colours, and Sound, are considered, demonstrating that these principles have most of the characteristics of corporalities—save that of ponderability or weight. In addition, will be a disquisition touching the qualitative causes of Resistance, and lastly will be annotations on Geology and Astronomy.

LITERARY NOTICES.

We have been favoured with a perusal of a portion of Mr. Hands' Work on "Matter, &c.," and can speak of it as a most able and interesting contribution to scientific literature.—*The Modern Physician.*—May, 1879.

Mr. Hand's Essays on Matter, Motion, Life and Resistance, &c., are replete with instruction and original conceptions of a very striking character.—*Human Nature.*—June 20th, 1879.

Mr. Hands, of Hammersmith, author of some very interesting works, has now adopted the plan originated by Dickens and Thackeray, whose books were brought out in monthly instalments. Mr. Hands's views are most original and illustrated by facts, his language stimulates the mental taste, like that of Robert Burton and Dr. Johnson, and pleases whilst instructing the reader.—*The Sussex Daily News.*—June 18th, 1879.

Attributes or Endowments of Materiality.

86. (*a.*) ELASTICITY is that capability which certain articles possess of recovering their primitive form and dimensions after the applied effort by which they may have been dilated, compressed, or bent, is withdrawn. The molecules of matter may—for the sake of illustration—be presumed to be acted upon by attractive and repulsive efforts. The attractive ability results from the action of the corpuscles on each other, the repulsive effort from the caloric and electricity, &c., surrounding them, which elements preserve a certain distance between each separate particle, and this space—though infinitely small—admits nevertheless of increase and diminution.

When a body is in that state commonly called *rest*, the opposite energies which any two of its contiguous molecules exercise on each other are in equilibrium, the energy of the abilities depending on the distance between the corpuscles. If the distance between the particles be increased within the limits of the action of the repulsive and attractive abilities, that is, short of what is commonly understood as rupture or separation, both energies are diminished, and if the distance is diminished both are increased, but not in the same proportion. As for example, if the interval at which the two energies balance each other be diminished—as by compression, &c.—the repulsive ability becomes the stronger or more active and the molecules are repelled from each other when the pressure, &c., is removed.

The principal phenomena of elastic bodies are the following:—First. That the elastic material (the elasticity being supposed perfect) exerts the same energy in endeavouring to restore itself, as that with which it was compressed or bent. Secondly. The energies of elastic substances are exerted equally in all directions, but the efforts chiefly take place on the side in which the resistance is least. Thirdly. When an elastic solid is made to vibrate by a sudden stroke, the vibrations are performed in equal times, to whatever part of the body in question the blow may be communicated. Thus, sonorous materials always emit sounds of the same pitch, and the difference of the note depends on the greater or less frequency of the pulsations of the sounding object. Fourthly. A substance perfectly incompressible cannot be elastic, therefore an object entirely solid has no elasticity, and hence also the small degree of resistance belonging to liquids, which are eminently incompressible.

Further touching Elasticity.

The hardest bodies, such as ivory, glass, marble, and ice, are *said* to be the most elastic or springy of all substances; yet india-rubber,

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from a single individual, only to be perceived by means of a high magnifying capability, is calculated to generate 170 billions in four days, about as many as would be contained in two cubic feet of the polishing-slate of Berlin.

The *Bovista gigantum*, a large fungus of the puff-ball tribe, has been known to increase, in a single night, from a mere point to the size of a huge gourd, estimated to contain 47 billions of cellules. Cell formation is an inherent property of living bodies, and is found in every form of organic matter, just as crystallisation appertains to the mineral world.

Fungi.—Mr. Fries speaking of them, states that their sporules (the productive substance or seed of flowerless plants) are so infinite, that in a single individual of the *Reticularia maxima*, "I have reckoned," he says, "10,000,000; they often resemble thin smoke, and are frequently raised by evaporation into the atmosphere, and become dispersed in many ways, by the wind and insects, &c.; it is difficult to conceive a place from which they can be excluded; they have been found germinating in the lungs of a living man, and often suffocate fish."

The transparent wings of certain insects are so attenuated in their structure, that 50,000 of them placed over each other would not form a pile a quarter of an inch in height. If a wire with the 432 hundred-millionth part of an ounce of gold spread over it be dipped in nitric acid, the silver within the coating will be dissolved, but the hollow tube of gold which surrounded it will still cohere and remain suspended. The blood globules of separate species of animals differ in figure and magnitude. In man and all creatures who suckle their young, they are perfectly round. In birds and fish they are of an oblong spheroidal form. In a drop of blood which would remain suspended from the point of a fine needle there must be a million of globules.

Small as these globules are, the animal kingdom presents beings whose whole bodies are still more minute. Animalcules have been discovered whose magnitude is so diminutive, that a million of them, as before noticed, do not exceed the bulk of a grain of sand; and yet each of these creatures is composed of members as curiously organised as those of the largest species. They have life and spontaneous motion, and are endowed with senses and natural impulses. They progress with astonishing activity, nor are their motions blind, but evidently governed by choice, and directed to an end. They use food and drink, from which they derive nutrition, and are therefore furnished with a digestive apparatus. They have also great muscular ability, which acts on their limbs; are susceptible of the same appe-

tites and obnoxious to the same disappointments as higher orders of existence.

Spallanzani observes, that certain animalcules devour others so voraciously, that they fatten, are indolent and sluggish from over-feeding. After a meal of this kind, if they are confined in fresh distilled water, so as to be deprived of all food, their condition becomes reduced; but they gain their spirit and activity, and amuse themselves in the pursuit of the more minute animals, which may be supplied to them; they swallow these without depriving their prey of life, for, by the aid of the microscope, the one has been observed moving within the body of the other. Must we not conclude that these creatures have vessels, muscles, nerves, circulating fluids and all the concomitant apparatus of a living organised body? And if so, how inconceivably minute must these parts be! If a globule of their blood bears the same proportion to their whole bulk, as a globule of blood does to our magnitude, what capability of calculation can give an adequate idea of its minuteness?

88. (*c.*) Crystallisation.—Liquids congelate or crystallise in freezing, and if aëriform bodies could by any means be reduced to the solid form, they would without doubt manifest the same result, as witnessed in the case of carbonic acid gas. Electricity, light, and heat produce remarkable results and both accelerate and retard crystallisation; but we at present have no positive evidence to show that either of these spiritous non-gravitating principles has any direct influence in determining the natural forms of crystals. Electricity appears to quicken the process of crystalline aggregation—to collect more readily together those atoms which seek to combine—to bring them all within the limits of that influence by which their symmetrical forms are determined; many evidences prove that polar magnetism has a *directing* influence upon crystallisation. It has been found that crystals of sulphate of iron, slowly forming from a solution which has been placed within the range of energetic magnetism, dispose themselves along certain magnetic curves, whereas the *Arbor Dianæ* or the common silver-tree, produced under similar circumstances, takes a position nearly at right angles or diamagnetic to their curves. Certain groups of crystals are often found in the earth, which show by their position, that terrestrial magnetism produced the phenomena they exhibit. Crystals are met with, exhibiting most microscopic characters, and also of an exceedingly large size. A crystal of quartz at Milan is three feet and a quarter long, and five feet and a half in circumference, and its weight is 870 lbs.

89. (*d.*) Impenetrability is that character of a body by which a material dwells in its locality to the exclusion of another, so that it

may be said, that no two things can simultaneously occupy the same place. Yet this impenetrability is more apparent than real, as regards masses, and can only extend to *atoms* of which a substance is composed; for when we dissolve a portion of a salt in a fluid, we do not increase its bulk beyond the contained water of crystallisation. Again, by mixing a pint of spirit with an equal proportion of water, the result is considerably *less* than a quart or the measure of the two; thus showing that there must be spaces between the *particles* of one body capable of being occupied by the atoms of another, or that they are caused by catalysis (action by presence) to approximate each other, which from the escape of heat—where condensation takes place—would appear to be the case.

90. (*e.*) Porosity is that state of the corpuscles of matter which shows that there are interstices or pores between them, for no two atoms of a body can touch each other, nor can we conceive an ability or energy capable of bringing them into contact; for if this was effected, *compressibility* and *elasticity* could not exist as a quality of matter. In proof of the porosity of bodies it may be stated that if a vessel of wood containing mercury or water be placed over the exhausted receiver of an air-pump, they may, by the pressure of the atmosphere, be forced through the wood, and fall from the ligneous bowl in a shower into the receptacle underneath. Again: The action taking place in the buds of plants, causes the sap to rise through the body of the tree up into its branches.

90. (*e, bis.*) Inertia is said to be the property by which matter is incapable of putting itself in motion, or arresting its own progress, when caused by extraneous energy. (See "Motion.")

91. (*f.*) Compressibility, or that condition by which the volume of every body may be contracted into smaller dimensions. All bodies, in consequence of the porosity of matter, are contractible, though liquids resist compression with immense ability.

92. (*g.*) Fluidity is that state of a body in which its constituent particles are so slightly cohesive or adherent, that they yield to the lightest impressions. The term is usually confined to express the condition of the once-supposed non-elastic fluids, and hence it denotes one of the three states in which matter exists—namely, solid, fluid or liquid, and gaseous. The state of fluidity is best defined as that in which bodies tend to form *drops*, as this disposition does not belong either to materials in a gaseous form, or to solid substances reduced to fine powder. The formation of drops arises from the circumstance, that the molecules of fluids adhere to each other with a certain tendency at the same time that they glide over one another, without any sensible resistance. A slight adhesion may be observed to exist

between the corpuscles or atoms of matter, when water or mercury is placed on a flat metallic plate. They there collect into globules, and when slowly poured into a glass, will remain heaped up—as it were—above the level of the edge. The equilibrium of the particles of matter may be said to be maintained between two energies, the attractive propensity, which tends to unite the molecules, and the repulsive ability that inclines to increase the distance between them. The solid condition may be said to result from the predominance of the attractive magnetic energy.

If we increase the repulsive ability so as to impart an augmentation until it becomes equal to, or forms an equilibrium with, the electro-attractive energy, the particles exerting on each other neither attraction or repulsion beyond the balance, the body will be in a fluid state. If the repulsive propensity be increased—as by the introduction of heat—the corpuscles will be separated from each other to such a distance, that their mutual attractions will cease to be sensible, and then the body passes into the gaseous or vaporous condition. We may then pronounce that there is no stationary *natural state*, and that fluidity, solidity, the condition of vapour, and the aëriform diathesis are only accidental, and determined by the temperature of the medium in which the body is placed.

93. (*h.*) Hardness may be considered as that quality of materials by which their molecules resist the action of any external application tending to alter their relative positions or impart to them any motion in respect to each other.

Hardness in mineralogy varies in degree according to the following scale:—1, talc; 2, rock-salt; 3, calc-spar; 4, fluor-spar; 5, apatite; 6, adularia (felspar); 7, rock-crystal; 8, topaz; 9, corundum; 10, diamond. Any mineral which neither scratches nor is grooved by any other of the above substances is said to possess the hardness expressed by the attached number.

94. (*i.*) Rigidity is said to denote the resistance to change of form, and is the opposite of flexibility. In mechanics it implies a resistance to change of form. Rigidity is often in the arts called *stiffness*.

95. (*j.*) Solidity.—The term solid is applied to that condition of matter in which the attractive propensities of the molecules are greater than the repulsive, and the particles consequently cohere with greater or less energy. In *fluids* the attractive and repulsive abilities are balanced, with *gases* the repulsive prevail.

96. (*k.*) Ductility or Tenacity.—A property of certain bodies, in consequence of which they can be drawn out at length without suffering any interruption of continuity or of their constituent particles.

The term ductility is frequently confounded with *malleability*, or that property of bodies through which different forms can be given to them by pressure or percussion. In general, ductility depends, in a greater or less degree, on the temperature. Some bodies—wax for example—are rendered ductile by a small degree of heat, while glass requires a violent heat before it acquires ductility. Some of the metals—for instance, gold, silver, lead, &c.—are ductile under all known temperature. The ductility of some metals far exceeds that of any other substance, as shown by the operation of the gold-beaters. Platinum and silver were drawn by Dr. Wollaston into a wire the 5,000th part of an inch in diameter. Glass, when well softened by the fire, becomes so ductile that it can be spun into threads as fine as that of the silk-worm.

The making of a wire from a bar of metal, or as it is termed, the drawing of wire, is nothing else than giving a new *set* to the particles composing the rod. Different metals possess the property of submitting to this new arrangement without giving way—which is termed *ductility*—in different degrees. Gold is most ductile, next silver, and platinum, and then iron, copper and zinc, tin and lead. Although the particles of the wire are less closer in approximation after the operation of *drawing* than they were before, yet they hold together more firmly—so that the *tenacity* of the wire or its ability of sustaining a great strain is augmented. A bundle of wires one-tenth of an inch in diameter, of such a size as to have the same quantity of material, will sustain a weight of from 36 to 43 tons, and if the wire be drawn more finely so as to have a diameter of only one-twentieth or one-thirtieth of an inch, a bundle containing the same quantity of material will sustain a weight of from 60 to 90 tons. For the sake of comparison it may be mentioned that a mass of hemp fibres glued together, will sustain a weight of 41 tons per square inch, whilst copper wire will not support more than 27 tons, silver only 17, gold 14 tons, and lead wire one and one-tenth ton per inch.

97. (*l.*) Weight.—In physics, that property of bodies by virtue of which they tend towards the centre of the earth. In this sense weight is synonymous with gravity.

Weight in mechanics denotes the resistance to be overcome by a machine, whether in raising, sustaining, or moving a body.

98. (*m.*) Gravitation (from "*gravis*, heavy").—Every particle of *atomised* matter has a disposition to press towards, and, if not opposed, to approach to, every other developed corpuscle; but this is only true when ponderable atoms or bodies are oppositely electro-polar, for if their points of apposition be both positive or both negative, they will repel or fly off from each other, as witnessed

by the approach of the like poles of suspended oblong magnets. A body which at the equator weighs 194 pounds, if transported to the poles would weigh 195 pounds. This result ensues from the *intensity* of the earth's magnetic undulations being increased in attractive energy.

Gravitation in regard to the Tides considered.—"The moon *is said* to be the principal agent in the production of the tides, but they are modified, both with respect to their height and the times at which they happen, by the action of the sun." It is assumed that the particles nearest the moon are attracted most, hence the rising up of the moveable waters, when the moon is on the meridian; but, in consequence of the rapid rotation of the earth about its axis, the spheroid equilibrium is never fully formed, for before the waters can take their level the vortex of the spheroid has shifted its position on the earth's surface, in consequence of which an immensely broad and very flat wave is formed, which follows the motion of the moon at some interval of time. In the open sea the period of high water is in general from two to three hours after the moon's transit over the meridian, either above or below the horizon. The waters of the ocean are affected in a similar manner by the sun, but being less in effect only modify those of the moon.

At the syzygies (conjunction or opposition), when the sun and moon come to the meridian together, the tides are, *ceteris paribus*, the highest; at the quadratures, or when the sun and moon are 90° distant, the tides are least. The former are called *spring tides*, the latter *neap tides.*

Tide wave.—Off Cape Horn, and round the whole shore of Terra del Fuego, from the western extremities of the Straits of Magalhaens to Stanton Island, the tide wave, instead of following the moon in its diurnal course, travels to the eastward, and a little further to the north the tide sets to the north-west. On the shores of Spain and North America, the tide is a day and a half old, at London two days and a half old, when it arrives. How does this fact account for two tides in the twenty-four hours?

Euler and Mr. Airy introduced the subject of fluid oscillations or undulations in their theories of the tides.—("Penny Cyclop.," vol. 27, p. 149.)

If we can divest ourselves of the witchcraft of attraction, and the pedantic display of irrelevant mathematics, we can have no difficulty in understanding the tides. "But we must look to facts, and avoid the closet fancies of those who never saw a tide. What is meant by the great tidal waves which go round the world in two or three days, we are at a loss to imagine. The maps of them will be monuments

of the folly of theory, and of the weakness, above all, of the silly theory of lunar attraction, with which such dreams are associated. We never saw or read of anyone that ever beheld the great tidal waves of the ocean."

The moon and planets add to their average motions certain oscillations about their mean places, the tides also consist of *oscillations* of the ocean about their uniform spheroid, which, but for the action of the heavenly bodies, would be carried round in the diurnal rotation of the earth.—("Penny Cyclop.," vol. 17, p. 43.)

The earth oscillates in exact periodic times like the other planets. There are fluctuations in the atmosphere and the mercury in the barometer rises and falls regularly twice in every twenty-four hours. —Herschel ("Astronomy," pp. 216 and 333.)

If the moon has any attractive influence upon the earth (more than what consists in the natural relation existing between the two bodies), why, when the moon is in conjunction with the sun, does not the water become *more elevated* on the side of the earth next to these bodies, as might naturally be expected if such attraction existed? Also substances upon that side of the earth would not then weigh nearly so much as when the moon was otherwise situated. Also when the moon is on the opposite side of the earth, and the earth sustains a position between it and the sun, why is not the elevation of the water equal at all portions of the earth? For if the moon and sun exert an equal influence, the result should be equal heights of water over the earth. A body rotating like our planet on its axis has the greatest tendency to throw off substances in the direction in which it revolves. As the earth turns on its axis, at the present time once in twenty-four hours, it must of necessity produce two elevations of the sea, especially as the waters surround the whole globe. Every twelve hours the aqueous element would be elevated at the extreme east and extreme west, or, in other words, at given antipodes of the earth. The elevation of water once in twelve hours is a result of the centrifugal tendency that the globe creates in one half of its period of rotation, corresponding tides being thus produced on the opposite side of the earth.

It was strange that so many calculating thinkers should have upheld the theory broached by Newton, relative to the influence of the moon producing the flow of the tides. But it may be said of most school philosophers, and Newton in particular, that they were and are chiefly *material fact hunters;* the unseen or intangible have or had no attraction for them. Newton was often little beyond a learned walking bundle of figure-calculations and handler of mathematical and other instruments, whose reflective faculties, like Lord

Bacon's, were too large for the other parts of his brain. He resembled many of those belonging to scientific societies, incapable of feeling or appreciating living natural productions. For instance, he was accustomed to term poetry ingenious nonsense, and his opinions of music and sculpture were as indifferent as those adduced relative to poetry. The forest and flowers of the earth had no attractions, and though he studied colours they had no charms for him. His friendship, or rather associations, alone extended to those who, like himself, dealt only in figures and mathematical apparatus; and, as for the passion of love, he, like Michael Angelo, Charles the Twelfth of Sweden, and William Pitt, avoided, when possible, the society of women and all their winsome attractions. Many other men who have gained eminence were one-idead, or so absorbed in a single pursuit that they were dead to most others. The sculptor and painter often think more of the marble and tools in the one case, and the canvass and pigments in the other, than they do of the lovely forms of *feeling* they are trying to represent. Again, the botanist has no elective sensibility towards the beautiful flowers he gathers; all his thoughts and leanings are engaged relative to their class and structure, and in pursuit of these, he tears the culled flower into pieces.

99. (*n.*) DENSITY in physics denotes the quantity of matter which a body contains under a given or determinate surface; for example, a cubic foot. The quantity of matter in any substance is called its mass, and is measured by the weight of the body, to which it is always proportional. Hence the density of any substance is great in comparison as its gravity is great and its volume small, or the density of bodies is directly as their masses and inversely as their volumes. It follows also from this definition that if two objects have the same size, their densities are directly as their masses or weights, and that if two bodies have the same mass or weight, their densities are respectively in the inverse ratio of their volumes. The density of a body is also proportional to its specific gravity.

100. (*o.*) TRANSPARENCY is that quality in certain bodies by which they give passage to the rays of light, and is generally supposed to be a consequence of the homogenity of the matter of which they are composed.

101. (*p.*) TRANSLUCENCY — SEMI-TRANSPARENCY. — These terms are chiefly used in descriptive mineralogy as applied to minerals which admit of a passage of the rays of light, but through which objects cannot be definitely distinguished.

102. (*q.*) OPACITY.—In optics that quality of bodies which renders them impervious to or incapable of transmitting light.

103. (*r.*) Malleability (from *malleus*, a hammer).—The property of being susceptible of extension under the blows of a hammer. It is especially characteristic of some of the metals, and in this quality gold exceeds all others. The leaf so produced from this metal is not more than a two-thousandth part of an inch in thickness: five grains may be thus extended so as to cover a surface of more than 270 square inches.

COLOURS.

104. (*s.*) Colours have generally been supposed to be merely peculiar undulatory properties of matter, but I am impressed to depart from this hypothesis and incited to place all hues among the imponderable spirito-material elements, like heat, sound, electricity, and certain odours, &c.

105. (*t.*) It is found that when particular colours are intermingled, their distinctness is unobservable or becomes lost, and the result is *white light*, or a hueless mixture. This sequent may be compared to the union of distinct melodious tones, the blending of which creates *Harmony*, and wakes up the feeling—especially when heard from a distance—as if they were constituted but of one sound. It is also known that when two or more hues are mingled together they form compound tints, producing the effect as if emanating from one pigment. This result may again be likened to certain vocal duets or trios, producing—when not too near—but one harmonious sound.

Colours have been proved to be always undulating or emanating from bodies, whether in the presence of light or enwrapt in darkness.

Proof of the materiality of colours can be demonstrated by intercepting particular rays from the spectrum, and thereby *disjoining* or rather *decomposing* certain of the mixed rays constituting white light. For instance, we cannot separate the *green* rays of the spectrum into *yellow* and *blue* by the refraction of prisms, yet a purplish-blue glass will attract or rather take up the blue rays and thus arrest them in their course and allow the *yellow* undulations only to pass; we are thus enabled to analyse the *green* as effectively as if they—the rays in question—were disunited by refraction. Similar results ensue when *dissecting* other colours.

106. (*u.*) Tinted wines when introduced into small tubes, exhibit no colour. Further, the green of the sea-water is not perceptible when put into a glass vessel. The reason of this result is, that the tinted undulations from the above-named fluids are too few or not intense enough to excite the fibrillæ of the phrenological organ of Colour, and hence the inability of detecting the hues of the fluids alluded to. The true condition as to the tints of different bodies

must not always be left to the decision of certain persons, for with many individuals the before-mentioned brain-organ is deficient in development as to its colour-detecting fibres. This is exemplified by the following cases :—A Mr. Harris, a shoemaker, at Allenby, could not distinguish the colour of a cherry from that of the leaves of the tree. His two brothers mistook *orange* for grass-green, and *light green* for yellow. A Mr. Scott pronounced *pink* to be pale *blue*, and a full red a decided *green* ; his father, uncle, sister, and two sons had the same defect. (See other cases described in "Brewster's Optics," pp. 311, 312.)

107. (*v.*) We often feel the effect of colours some time after the object from whence they emanated has been removed from our presence. The above result ensues from the memory, as it were, of past excitement, which is kept up by the vibratory action of the nerve-loops, appertaining to that portion of the brain adapted for the reception of tinted rays.

108. (*w.*) The coloured spectrum (according to "The Year Book of Facts") has been engraved on the daguerreotype-plate, further demonstrating that colours are effectively material ; a nothing could not produce sequents.

Very few persons, if requested to mark with the point of a needle, the limits of the coloured rays, will single out the same spot, and other individuals fail to perceive certain tints. The eyes of these different parties are the same, but not their brain-organisation.

109. (*x.*) Herschel was the first that obtained any good specimens of photographical impressed prismatic colourations. Daguerre had noticed that a red house gave a red image on iodized silver plates in the camera obscura. Fox Talbot found that a red coloured print was copied of a red hue on paper spread with chloride of silver. A paper prepared by washing it with muriate of baryta and nitrate of silver, and allowed to darken whilst wet in the sunshine to a chocolate colour, was placed under a frame containing red, yellow, green, and blue glasses. After a week's exposure to diffused light, this prepared paper becomes red under that coloured glass, yellow and green when beneath these latter tints, and light olive under the blue glass.

110. (*y.*) The elements constituting colours may be conjectured to exist in the atmosphere and throughout all space and should be ranked with light, heat, and electricity, being, like them, a subtile unparticled imponderable material ether. These colour-principles can only be made evident to our senses when in union with atomised gravitating matter, which, accordingly as bodies change either in quality or composition, will radiate or undulate different tints. Thus

there is no discoverable relation between the colour of a ponderable compound and that of its elements. For instance—iodine is of a deep iron grey hue, its vapour is violet, it forms beautifully white salts with the alkalies, a splendid red compound with mercury, and a yellow one with lead. The salts of iron vary from white and yellow to green and dark brown. Those of copper (a red metal) are of a beautiful blue and green colour.

111. (*z.*) Different coloured glasses transmit dissimilar quantities of heat. Thus red admits the passage of 17 deg.; orange, 27 deg.; yellow, 45 deg.; green. 42 deg.; blue, 47 deg.; indigo, 70 deg.; violet, 15 deg.

When wood or ivory is burnt or oxydised by electricity, the spectrum is crimson; silver and leather produce green by electrical ignition; and powdered charcoal yellow.

112. (*aa.*) The blind youth couched by Chesselden thought scarlet the most beautiful of all colours, but black was painful to his feelings. He fancied every object touched him.

113. (*bb.*) Claudet states that blue proved to be the most able photographic agent, and yellow the weakest. He threw the prismatic spectrum on paper, and also on the silver plate, the colours being marked on the paper, and the effects remaining on the photographic plate. He thus showed that the photographic prism presents results different from the apparent intensity of the prismatic spectra. He further observes that the rays which make the photographic picture are *different* from those of light.

114. (*cc.*) *Light* has been said to be a great mystery. Spirit itself is not more incomprehensible. It is a principle that makes all common matter visible, therefore it must be matter itself. Mysterious as this spiritous principle is, it can be analysed, and is found in combination with many other elements. All *colours* are associated with it, and they are almost innumerable. Heat travels along with it, and also another substance called *actine*, or actinism.* These principles—light, heat, and actine, &c., are perfectly distinct, and they can all be separated. Thus rock salt transmits 92 and alum only 12 per cent. of heat, and yet the same substances are permeated by a like amount of light. Again, black glass, which gives passage to a very small portion of light, allows 90 per cent. of heat to go through it. Yellow glass, that intercepts little or no light, but preserves the full glory of the sunbeam which has passed through its substance, changes altogether the chemical character of the light, for the actine has been

* From the Greek word *actin*, signifying a solar ray, and implying an active principle.

stopped at the outer surface, and can be no longer discovered. This actine is the element which produces the chemical changes on coloured substances, and is therefore supposed to be indispensable to the production of daguerreotype likenesses. Hence it follows that in a room with yellow window-glass the portraits are not forthcoming. No impression is made on the iodised plate, not even by the image of the sun itself. Nay, the picture of the solar luminary, received through yellow glass, even protects the otherwise sensitive plate from change, thus proving that it is not light, but the influencing actine of the solar ray, that produces these exquisitely delicate and accurate pictures. They can even be taken in the dark, for actinism can penetrate black or deep blue glass, which shuts out light, and it can be introduced without light into a room with the dark or blue end of a solar spectrum refracted by a prism, and the actinism is all that is necessary for the action of the daguerreotype.

115. The three principles found in a sunbeam will be actine, heat, and light, and are divided between three colours—blue, red, and yellow. Blue contains the actine, red the heat, and yellow the light, in the largest proportion. If you decompose a *compound* ray of light by means of a prism, you find that the colours will separate in the following manner:—Yellow occupies the middle, blue one side, and red the other. These are all the original colours of light. The rest are compounds, made up of one ray overlapping or rather intermixing with another. Thus the spectrum reads from above downwards, thus: —first, the heat ray; then, second, red; third, yellow; and fourth, blue colour-beams; and lastly, fifth, the chemical or actinic ray. Actinism prevails in spring, light in summer, and heat in autumn. Now actinism belongs chiefly to the blue rays. It follows, therefore, that a plant which is covered with blue glass in the spring of its existence is placed in more favourable circumstances than one that is covered with yellow glass; for yellow vitreous substances prevent almost entirely the transmission of the actinism. Under the yellow glass the young plant will not germinate. In the summer of the plant's life, however, when light is principally required for the selection or *creation* of the carbon, which increases the bulk of the plant, the yellow glass becomes more favourable. In the autumn, red glass is conducive to the transmission of heat, which is chiefly required for the ripening of the fruit. It is owing to the abundant supply of actinism in the polar regions that vegetation during summer progresses with such singular rapidity in those cold climates. The deficiency of heat prevents the growth of innumerable plants which can only be reared in temperate and tropical climes; but the vegetation that can be reared in cold regions comes quickly to maturity, and

spring, summer, and autumn are all compressed within the small compass of two or three months. In tropical regions, on the other hand, the heat is more abundant than the actinism. This condition of things is favourable for fruit and plants, but not for daguerreotyping. It has been proved that under a clear tropical sky no pictures could be taken, but no sooner does the rainy or winter season set in and the light diminish, than the actinism is increased, and the photographic plates and paper become sensitive to its influence. This is the season when Nature in the East shoots forth her buds and covers the ground with grass in a few days. It has hitherto been supposed that this luxuriant effect is the sole product of heat and moisture, but it is now demonstrated that the actinism in the light is an indispensable agent, without which the radiant heat and moisture operate in vain. This actinic agent, working in darkness or defective light, also accounts for the rapid progress which in moist summer-weather all sorts of plants generally make in the night and morning, for, though light and heat are necessary to the strengthening and ripening of vegetation, the shooting and opening of the bud is the work of the actine, and so averse are flowers, which are fruit in embryo, to the mere principle of heat, that they naturally avoid the red rays and turn round to the yellow and the blue.

116. Baron Reichenbach's clairvoyant subjects could discern different coloured undulations bursting from all bodies, but especially the magnet. These latter resembled the *aurora borealis*, and extended a long way fromthe object, and were white, yellow, red, &c. Further, each metal was perceived by the Baron's patients to throw off particular and characteristic undulations all differing according to the substance from which they emanated.

Action of scents and colours.—That odours, like different tints, are material principles is demonstrated from the following facts. For instance, coloured bodies imbibe effluvia in the same ratio as heat. Thus black cloth has a greater capability of absorbing odorous emanations than white. Red cloth is intermediate between them. Cottons and silks gave the same results, which were *confirmed* by the different weights acquired by these substances from the deposition of camphor upon them.—(*Philosophical Transactions*, vol. iii., p. 208.)

117. Certain persons are almost destitute of the ability of perceiving colours. Spurzheim relates that he knew a family, all the individuals of which distinguished only black and white; Dr. Unzer, of Altona, could not perceive green and blue; and Dr. Spurzheim states that at Vienna he saw a boy who was obliged to give up his trade of a tailor because he could not distinguish different colours. The Doctor met with similar instances at Paris, Dublin, and Edin-

burgh. Those who do not perceive colours have sometimes a very acute sight, and readily appreciate the other qualities of bodies, as their size, form, &c. There is nothing more common than that a painter should be an admirable draughtsman as to outline, but a vile colourist. Thus, as the faculty of perceiving and employing colour is not in proportion to the sense of sight, or to the understanding in general, there must be some particular organ which recognises, judges, and recollects the relation of hues. The phrenological development of colour is therefore necessary to painters, dyers, and all who are occupied with different tints. It is this faculty that is charmed with the flower-garden and the enamelled meadow. The organ which takes cognizance of colours is more active in women than in men because they more frequently exercise this development and are more sensitive to external agents. Certain nations excel others relative to this quality. The organ of colour is situated in the middle of the curve in the eyebrow. Its great development is proclaimed by a full and much-arched eyebrow; this external sign, however, is less certain than when the curve is drawn outwards and upwards, so that its outer part is more elevated than the inner.

118. The Rev. C. H. Townshend, in his work on Mesmerism, pp. 253 and 266, relates many cases in his experience of clairvoyance, where the patients could distinguish all kinds of colours in perfectly darkened rooms. The individuals in question could also accomplish this feat when the tinted objects were at a great distance from the house where they were then sojourning. This ability was always enhanced by practice. I myself have very frequently experienced the same results. These facts tend to show that colours are endowed with the attributes of spiritous materiality, like light, heat, sound, and electricity, &c. I am here constrained to advance still deeper into nature's labyrinths of possibilities, and shall presume to announce that I strenuously believe our very thoughts and feelings—with the effects they produce—become spiritously materialised, and may be, as it were, pictured or impressed upon the adjacent atoms that at the time surrounded the unfolding circumstances.

Further, these shadowed effects may become, by magnetic association, connected with or mapped out upon all the most distant corpuscles in the universe. These probabilities are awakened in my reasoning faculties, from the facts, that I have known clairvoyants describe the acts and feelings resulting from the efforts of the soul operating on the body, and they have imaged correctly the cogitations and impressions that possessed certain persons (though at the moment of relation forgotten by them) in the long past periods of their lives. I have heard these seers narrate or point out the asso-

ciations and relations to which a particular ring or piece of furniture might have been exposed through lengthened periods of their use.

These events announce to us, that each mind-born image must be materialised and last for ever, and that it will have a shadowed existence, when Time's ancient temples—fashioned by the hands of men but to perish—shall have crumbled into dust, and become a nothingness, or no longer discernible by the common eyes of mortals.

119. *Touching partial or total colour-blindness.*—It may be suggested by certain thinkers, that the soul ought to perceive or recognise the existence and qualities of all things. Further, these cogitators may be incited to ask, Why it is that the inner selfhood of certain persons fails to perceive the particular or special qualities of objects? This question may be best answered by pointing out, that the soul, relative to some things, requires, like other existences, to be impressed or educated through *certain* channels, namely, particular animal senses, and especially the phrenological organs—the absence of which, or, rather, a deficiency in their development, must prevent the mind from reaping knowledge and experience through instruction, and thus is prevented the employment of some of its capabilities.

120. I think from the foregoing evidence, it must be conceded that colours have a sensible and even tangible material existence, and, like heat and electricity, they form a part, or are mixed up with, every substantive object, whether solid, fluid, or aërial; and accordingly as these latter materials are being developed, or even altered, after their production, they will, on being incited into action, display their tinted component parts, which, when evolved, can be readily recognised by the different fibres of the organ of colour, as the fibrillæ of the development of melody estimate harmonious sounds. It may be observed that the slightest changes or alterations among the corpuscles in many of the bodies that surround us, unfold, or rather bring into more or less action, their emanating rays of coloration, which operate on our sensibilities, calling forth their appreciation. It may be readily conjectured, that as there are dissimilar kinds of colours, so, no doubt, there must be different species of electricity and heat; but as we have no distinct organic nerve-loops in the brain to recognise the varying characters of these latter elements, they cannot be separately distinguished, and *at present*—in our common condition—can only be appreciated by the senses that take cognizance of warmth in the one case, and magnetic excitability—as regards electrical undulations—in the other.

121. Phosphorescent bodies, and the diamond, &c., are endowed with the quality of absorbing luminous rays, and the former can also

take up different colours, and then radiate them in the absence of light. The persons appointed to recognise these results must occupy a darkened room, and have the substances which have been experimented upon by exposure to the tinted materials and to the sunbeams or Drummond's light, handed in to them.

122. Coloured bodies, when exposed to Drummond's light, appear as if placed in the sun's rays, but in certain artificial lights, substances assume the hues of the flames they are exposed to. Thus, in the theatres they employ salts of soda to produce yellow, and the nitrate of strontium is used to give the flame of burning bodies a fine rose red; boracic acid dissolved in spirits of wine produces a green flame when burning. These experiments show that colours are capable of undulation, and that they can emanate from ignited materials and be deflected from surfaces like solids. These tinted rays are reflected by some substances as if they were of the same colour as the burning light; but with materials of a similar hue to the flame in question, the original tints are enhanced or become more intense.

Every body, indifferently, whatever be its hue in white light, when exposed in the prismatic spectrum, appears of the colour appropriate to that part of the spectrum in which it is placed: but its tint is incomparably more vivid and full when laid in a ray of colour analogous to its own hue, than when exposed to white light or any different tinge. For example; vermilion placed in the red rays appears of the most vivid red; in the orange, orange; in the yellow, yellow, but less bright; in the green rays it is green: but from the great inaptitude of vermilion to reflect green light, it appears dark and dull; still more so in the blue; and in the indigo and violet it is almost completely black. On the other hand, a piece of dark blue paper, or Prussian-blue, in the indigo rays, has an extraordinary richness and depth of blue colour. In the green its hue is green, but much less intense; while in the red rays it is almost entirely black.

The action of Chemicals on Colouring Matter.

123. Some blue substances are reddened when operated upon by an acid; other bodies of the same hue are not so affected. Paper tinged blue by litmus (a purple pigment called *archil*, obtained from the lichen *Rocella*, of the Canary Islands), is made red by the application of acids, and again turned blue by alkalies. Further; yellow turmeric-paper is rendered brown by the use of free alkalies, and is again restored to its original hue, after being dipped in an acid. The foregoing facts most positively show that colours are substantive and material—altering, disappearing, and combining, after the manner

of other bodies, and then, like them, by chemical processes, set free and restored, when not decomposed, into their ultimate original character.

124. Chlorophyll (Greek *chloros*, green, and *phullon*, a leaf). This green colouring matter of the leaves, &c., of plants, undergoes changes by forming different combinations; hence the dissimilar hues of the botanical world. Plants are often of one colour in the morning, and another in the evening. Again, certain white flowers may be tinted by acids and alkalies. In addition, some blossoms are acid in the early part of the day, and alkaline at its decline or sunset; hence their varied tints.

Chlorine destroys the colours of plants by decomposing the component constituents, of which these said colours are made up, into their ultimate elements of undeveloped or unparticled matter; consequently, after the operation of this gas, the different hues of the leaves and blossoms of the growing vegetation cannot be restored.

125. When hydrogen is projected through a copper pipe, previously to lighting it, the colour of the flame will be green. If this gas is passed along a glass tube and then ignited, the luminous jet is tinted yellow, from the soda contained in the vitrious conductor, so that the different compounds which the gas touches or imbibes alter or change the colour of its flame.

126. Again, we can show that matter, with its combined colouring principles, is necessary to the production of different hues. This is made evident when passing a current of electricity through transparent tubes containing air. When the atmosphere is present in the hollow glass piping, the projected electrical stream appears white; but as the tube is being exhausted, the current becomes darker or of a blue tint, and when the vacuum is completed, the stream is then imperceptible, because the imponderable matter constituting colour, light, and heat, always resident in common air, has been withdrawn.

127. The tints of bodies, from their different undulatory principles being rendered more intense, generally deepen by the application of heat, as is known to all who are familiar with the use of the blow-pipe; thus minium, red oxide of lead, and red oxide of mercury, darken in their hues by the action of caloric till they become almost black, but recover their red colours on cooling. Among artificial glasses and transparent minerals a transition takes place from red to green, on the application of a high temperature; the original tint being, however, restored on cooling, and no chemical alteration having been produced in the medium.

128. *Colouring matter* has an existence independent of the influence of light, which only serves to show its being. Thus, with the hydro-

phytes, or water-plants, some of these live in the gulfs of the ocean, at the extraordinary depth of one or two thousand feet; and although in such situations there must reign darkness more profound than "blackest night," at least to our organs, many of these vegetables are highly and beautifully coloured.

129. A mineral dug from the earth's deepest recesses may have the property, when brought to light, of displaying the most brilliant colours; although up to the time of its disinterment, not a luminous beam had ever fallen upon it. This property of reflecting or throwing off tints was not, of course, produced in the stone through the agency of light. Again, a fluid prepared in a dark laboratory, when examined by daylight, will reveal the most exquisite tints. It is otherwise with plants; here light acts as an agent, causing them to secrete, or rather, form, out of unparticled matter, certain compounds capable of emitting colours.

130. THE COLOURING MATTERS OF FLOWERS can be readily extracted; many of them are fugitive and change considerably in tint, and are often altogether destroyed on drying, being resolved into their ultimate elements; others are comparatively permanent; the tinted juices are often altered when expressed—thus the red becomes blue. The violet is coloured by a blue matter, which is changed to red by acids, and first to green, and then to yellow by alkalies.

ORGANIC COLOURING MATTERS.—Such as are soluble in water often partake of the nature of *extractive matter*, and although fugitive in themselves, are capable of being combined with and fixed, or rendered permament, by certain *bases* or oxides which, in reference to this particular case, have often been termed *mordants*.

131. The circles of colours—like those in the peacock's tail—that appear upon pressing one corner of the eye with the finger, are produced by exciting into vibratile action the fibrillæ of the phrenological organ of *colour*.

132. That colours are material *somethings* or acting substances, as before noticed, was shown by Dr. Stark (*Phil. Trans.* 1836), who demonstrated that dark colours retain odours more permanently than those of a lighter hue.

133. Further, certain animals, especially fish and birds, rapidly lose their bright hues after death. In fact, all tinted bodies, whether living or dead, radiate, more or less, colouring matters; hence their continued changes. But, with this difference, living objects can alter, replace, or rather, create particular pigments; whilst fading, dead objects have not this ability, hence their substantive tints, when exposed to favouring circumstances, become decomposed; or they again melt and revert into their ultimate unparticled principles,

out of which they were originally formed or called into perceptible being.

134. If, after breathing on the point of a pencil, I apply it over the organ of *colour*, appertaining to a person in the mesmeric sleep-waking state, and thereby excite a single fibre or nerve-loop of this development, the individual so acted upon can only distinguish or become sensible of one hue—say, yellow. Now, if the apex of the applied instrument be moved the tenth part of a line from the locality originally touched, the patient then perceives blue alone; but if I apply a second pointed instrument to the part originally acted upon, the person so influenced becomes conscious of a mixture of the two colours as green, and, accordingly as the stylus is moved, so will the hue vary to the person manipulated. If a larger portion of the organ of *colour* be excited, as by touching it with the finger, the tints become confused, or the somnambule perceives a variety of colours. Further, when after the same manner I apply a pointed instrument over the organ of form, the patient perceives—say, the outline of a triangle, and if I place an inked pen in his hand, he can then only draw triangles.

Now, if the point of the rod be slightly shifted over a different portion of this development, then ovals are alone depicted. Again, on moving the pencil to another portion of the organ of Form, and at the same time placing a pair of scissors in the sleeper's hand, I become surprised that the party in question can only cut out octagons, &c., &c. These experiments show that every fibre of the sensorium has a distinct office or ability, and possesses a faculty capable of some distinct function. If the human brain was unfolded so as to display its fibres as demonstrated by Gall and Spurzheim, it would be found that twenty skulls would not hold the ravellings that could be displayed.

135. *The effects of colours on different objects, displaying the materiality of colorific rays.*—Under ordinary circumstances, says Mr. Hunt, plants bend *towards the light.* In all my experiments with red fluid media *they have as decidedly bent from it.*

136. The wild and savage buffaloes found in the thickets on the Pœstan plains are readily excited, like the pheasant, by glaring colours. Thus, a German artist, who went to sketch the magnificent remains of the neighbouring temples, once incurred great risk by pulling out a red bandanna pocket-handkerchief, the sight of which so infuriated these animals that he was obliged to fly for his life. In the Neapolitan games, a buffalaro, well mounted, and whose horse is trained to turn short on his haunches, and to be perfectly "in hand," undoes the long scarlet sash he wears

round his waist, and, shaking it in the air, provokes the animal to pursue him.

137. The hyla, or tree-frog, like the chameleon and iguana, changes its hues in accordance or from sympathy with the colours of surrounding objects.

138. The pigmental layer of the skin, analagous to the *rete mucosum* in the octopods, says Mr. Owen, consists of numerous cells, containing coloured particles suspended in a fluid. The hue is rarely the same in all the cells; the most constant kind generally corresponds more or less closely with the tint of the inky secretion. In the *Sepia* there is a second series of vesicles, containing a deep yellow or brownish pigment; in the *Loligo vulgaris* there are three kinds of coloured vesicles—yellow, rose-red, and brown. In the *Octopus vulgaris* there are four kinds of sacs—red, yellow, blue, and black. In the skin of the *Argonauta* all the colours which have been observed in other cephalopods are present, and contained in their appropriate cells. These vesicles possess the capability of rapid alternate contractions and expansions, by which the pigment can be driven into the deeper parts of the chorium, or brought into contact with the semi-transparent epidermis or scurf-skin. If the surface of an *Octopus* be slightly touched, the colour will be accumulated gradually or rapidly, like a cloud or blush, upon the irritated cuticle. If a portion of the skin be removed from the body and placed in sea-water under the microscope, the contractions of the vesicles may be watched for some time. Their margins are well defined, and they pass, during their dilatations or contractions, over or under one another. The ability which the cephalopods possess of changing their tint, and of harmonising it with that of the surface on which they rest, is as striking and extensive as in the chameleon and common trout, in which it seems to be produced by a similar property and arrangement of pigmental cells.

139. The *Geckotidæ* adhere to bodies by forming partial *vacua* under their feet; they have kidneys, but no bladder. These lizards put on the hues of the localities they inhabit, are very quick in their movements, and *can perceive objects in the dark*. All these ugly reptiles are said to blister the skin by the touch.

140. Colours, like odours and sound, occasion, through the medium of the brain, distinct effects; thus blue *tranquillises*, *yellow* causes *confusion*, red excites the nervous system, and acts on the spirits. It is almost impossible to classify the numerous and dissimilar effects which the diversified hues of nature develop in the entire individuality of man. Different tints often produce strange effects on certain persons. The time and extent of the action of light, and the operation

of diversified colours upon the spiritual principle, are as particularly measured and governed as is the circulation of the living blood or nervous fluid. The influence of *violet* is generally soft, mellow, pleasing, and tranquillising; red is the most exciting element, and the lowest in beauty. The intense action of *red* upon the medium of sensation produces great, and sometimes uncontrolable, excitement in susceptible minds. Some animals are infuriated, and certain individuals are thrown into paroxysms of nervousness, or delight, by the sudden presentation of *red* to their senses. Africans are passionately fond of this colour; it imparts pleasurable sensations, suggests simple enjoyments. It influences them to sing, after their fashion; also to dance and go through a great variety of pleasing gymnastic performances.

141. There was a bookseller at Augsburg, blind from birth, who maintained that it was not the eye, but the nervous intellect, which recognised, judged, and arranged the proportion of different hues. This man assured his friends that it was by means of an internal sense that he had precise notions of colours, and it was a fact that he determined their fitness with exactness. This bookseller had a variety of different tinted beads, with which he formed dissimilar figures; and the arrangement of the colours was always harmonious. He stated that whenever he took much pains to arrange the hues of a ground he felt a pain immediately above the eyes. The region which I have indicated as the organ of Colour was greatly developed in this man. (Gall, vol. v., p. 53.)

142. The electrical conducting abilities of bodies vary, and are often affected by the colour of the thread, or rather the nature of the dye-stuff by which it has been tinged. When of a brilliant white or a black character, its conducting capability is the greatest, and a high golden yellow or a nut brown renders it the best insulator.

Marichini and Mrs. Somerville communicated *magnetism* to steel wires by exposing them to the violet rays.

143. A plant, after it has reared its head above the surface, if it be permitted to vegetate under the influence of the blue rays, will for some time exhibit a luxuriant growth, and present in its earlier stages an appearance far superior to that of plants grown under white light. The leaves will be of a darker green, and altogether the plant will show signs of vigorous health, although it will be more succulent and contain less woody fibre than under other circumstances. Gardeners employ deep blue glasses to assist in the development of roots from cuttings.

It is found that vegetable colours are bleached, not by the rays of their own character, but by those which are *complementary* to them.

Thus a red dye fades under the influence of a green ray, and a yellow beneath that of a blue one more rapidly than when exposed to rays of any other colour.

Vegetation and animals vary in colour from the base to the top of mountainous countries.

144. Some of the inhabitants situated in the interior of Ceylon are without the organ of Colour, and have no words to express this element. These people are of a diminutive stature—about four feet four inches in height. They have no religion, and are without the phrenological organs of Memory, Number, or Order.

145. Previously to entering further into the disquisition touching the qualitative materiality of light, I deem it desirable to place before the reader a list of the recognised elements mostly contained in the earth's atmosphere; suggesting, at the same time, the presence in it of other particular (though not as yet recognised because at present undemonstrable) amorphous imponderable substantive elements. I shall further venture to propose the positive materiality of certain definite existences always persistent in the air, which at this epoch are generally considered to be merely the result of a series of special definite pulsatory conditions of motion; as for instance the elements or principles constituting sound and colour, &c. I am further impressed to suggest that there must always be a *something* which moves or causes motion, and this something should partake of the properties essential to materiality. The most fertile imagination cannot, I presume, conceive a nothingness producing effects.

As regards the constituents of our aërial element, among other things mixed up with it will be found gravitating atomised matter as—1, oxygen; 2, nitrogen; 3, sometimes free hydrogen; 4, carbonic acid; 5, ammonia; 6, watery and other vapours; 7, sulphuretted, phosphuretted, and carburetted hydrogen; 8, floating animal ova; 9, the seeds of certain plants and the sporules of others; also, 10, particular *bactria* or rod-like fungoid germs. Accompanying the above must be particularly noticed the motory, creating, corporeal, spiritous principles of—11, light; 12, electricity; 13, magnetism; 14, the chemical principle of actinism; 15, the elements constituting colour; 16, the matter by means of which sound is produced. Further; 17, odorous exhalations (healthy and noxious); of the latter are the miasms of intermittent and other forms of fever and certain contagious diseases; 18, meteoric magnetic iron, &c., &c.; all these, or their effects, have been detected and demonstrated as resident in the air we breathe. But, added to these, there must be certain special undeveloped and consequently unatomised, and non-gravitating yet material elements, which in coming time will be made evident to our perceptive faculties,

and their manner or mode of use shown, relative to their chief employment in the formation, or materialisation of the vegetable and animal kingdoms, which have produced all the later crusts of the continually enlarging earth, except, perhaps, the meteoric iron aërolites that fall by millions every year upon the surface of our planet.

LIGHT.

DISSERTATION *on the Materiality of Light, or Radiant Imponderable Matter.*

146. Huygins, Euler, and Descartes thought that light consisted of vibrations extending through a rare elastic medium, which fills all space; while Newton considered it as resulting from the emanations of particles of matter from bodies. Dr. Young held to the former theory.

The undulatory waves of light have been proved to move 192,000 miles in a second, and are 8 minutes and 13 seconds (Herschel says 7½ minutes) in reaching the earth after being excited into vibratory action by the sun; whilst a projected cannon-ball, travelling at its usual rate, would take 20 years (Herschel says 17), and sound 14 years and 87 days, in performing the same distance.

147. *Light is capable of refraction*—that is, breaking towards the perpendicular—when the ray proceeds into a rarer medium, and from the perpendicular when the beam passes into a denser medium. A ray of light, then, forms a curve to reach the earth (and varies in its arch according to the temperature of the different strata of the terrestrial atmosphere), and thus we see a star before it rises. Different bodies vary in their refractive ability, as hydrogen, the diamond, amber, turpentine, and oils. Newton inferred from this fact that the diamond was combustible, because it refracted light like the latter substances.

148. *Reflection of Light.*—When luminous rays arrive at the surface of bodies, a part of them, and sometimes nearly the whole, are thrown back, or *reflected*, and the more obliquely the beams fall on a surface the greater in general is the reflected portion. In these cases the angle of reflection is equal to the angle of incidence. Malus, in 1810, discovered the *polarisation of light by ordinary reflection* at the surface of a transparent body. He found that when a beam of light is reflected from the plane of such a body, *at a certain angle*, it acquires the same singular property which is impressed upon it in the act of double refraction (as when split into two by passing through Iceland spar) and the phenomena of polarisation are in this way exhibited.

149. *Phosphorescence.*—No heat ever accompanies phosphorescent light, nor does it produce chemical change. By the prism we detect

the same number of colours in a phosphorescent beam as in the sun's rays. Many bodies exposed to the solar beams give out light when examined in the dark, as with the flowering nasturtium. If the human hand be held in the sunshine for a time it will emit light after the exposure for some minutes in the dark. The bodies which chiefly display this property are the Bolognian stone, a sulphuret of barium; and Canton's phosphorus, which is prepared by calcining oyster shells and sulphur together. If these substances are exposed to the solar rays they acquire the property of shining in the dark so strongly as to enable the observer to read a book by them. Other substances exhibit these phenomena, as Homberg's phosphorus, melted chloride of calcium, and also nitrate of lime and sulphuret of strontium, &c. The above results show that light is a divisible *something* or radiant material, and not an undulatory *nothing*. This luminous ability of certain bodies is diminished by cold; they are more brilliant in dry and warm than in cold, wet weather; they shine most intensely after exposure to direct sunshine, but some of them, especially Canton's phosphorus, glow in the dark after mere exposure to ordinary light. Some persons report that these substances can absorb and then give out coloured lights.

The beams from the moon do not produce the foregoing phenomena, but burning gunpowder, a lamp, or electricity will.

A diamond which had been placed in the solar rays, and then covered with black wax, was found to shine, several years after exposure, on removing the wax. Chemists have exhibited, to a high temperature, a mixture of sulphur and zinc, excluding every substance from which they might obtain oxygen. The two substances united, forming a pure sulphuret of zinc, and at the moment of combination, they gave out vivid light, showing this principle to be a material capable of combination with other bodies.

Aristotle and Fresnel supposed light to be a pure, subtile, homogeneous medium, or imponderable, material ether, pervading not only all space, but every substance in nature.

150. Faraday was enabled, by means of a strong electro-magnet, to attract rays of light as readily as if constituted of a bundle of iron wires.

151. All bodies on which light falls absorb a certain part of it, giving an increase of energy to their distinctive undulatory qualities, which are at all times escaping from them, whether in darkness or light. It is this enhanced intensity of the vibratory attributes of substantive existences that make us, in our common state, aware, from habit or use, of their presence through the source of vision.*

* See the author's work on Will-Ability, pp. 12, 37.

152. *The motor ability of light.*—Mr. William Crookes, F.R.S., suspended an exceedingly light lever-arm of glass to the end of a fibre of spun glass, 8 inches long, inside a glass tube. To each end of the lever-arm a disc of pith was fixed. As soon as the tube was filled with air, the warmth of a finger instantly repelled the lever-arm. When there was a partial vacuum of 30 millimetres, external heat would not move the arm; but on making a very perfect vacuum, the lever-arm was repelled by the warmth of the finger. Light also attracts or deflects the lever-arm under like conditions.

153. *Spectroscope.*—The dark bands of Dr. Wollaston and Fraunhofer seen in the solar spectrum or image, are constantly found in the same position and preserve a like order and relation to each other; but in the light of the stars, the electric light, and that of flames, though similar bands are observed in their spectra, yet they are differently disposed; and the spectrum of each star and each flame has a system of bands peculiar to itself, and characteristic of its light, which it preserves unalterably at all times and under all circumstances. Every known metal during combustion has its own particular bands, and in no case are the ribbon-like stripes of two metals alike in refrangibility. It follows, therefore, that these spectra may be made a sure test for the presence or absence of any particular metal, for even their salts yield the same bands.

Iron, calcium, barium, magnesium, manganese, titanium, chromium, nickel, cobalt, hydrogen, aluminum, zinc, and copper, all exist in the atmospheres of the sun, as shown by the lines on the spectrum. There are a number of dark lines produced in the solar spectrum, which do not correspond to any known terrestrial elements.*

It has been lately demonstrated that the slightest chemical alteration in the blood betrays itself, immediately, by a corresponding change in the blood-spectrum, as where poisons have been taken, or even when a person has been killed by carburetted hydrogen (fire-damp). From the foregoing we may presume that light is an undulating imponderable material, which serves as a carrier, so to speak, of the *de-atomised* metallic elements that are found to imprint themselves on or in the optical image of the sun formed on the screen.

154. The sun, says Dr. Henry, is not the source of light. If it were not for the atmosphere, there would be neither heat nor light manifested in our aërial element. This planet is a feminine orb, which produces both light and heat by the agency of the sun. On the tops of mountains, the air is rare, and the cold consequently intense and

* The sun must be surrounded by an envelope holding various metals and other substances in a state of vapour.

the sky very dark; further up, you would still see the stars and the sunlight, but perish with cold.

155. Claudet made many experiments whilst forming pictures by reflected light, but had not been able to discover any essential difference between them and such as are formed by the direct rays from the sun. His next series of experiments regarded the photographic qualities of light and different colours. Blue proved to be the most able photographic agent, and yellow the weakest. One of the most beautiful experiments by which this was proved, consisted in throwing the prismatic spectrum on paper and on the silver plate, the colours being marked on the paper, and also remaining on the photographic plate.

This latter result most positively proves that colours consist of unatomised or imponderable material elements, and can be radiated like the qualities of solid bodies, which are known to be capable of engraving or impinging themselves on sensitive surfaces.

156. The rays of the sun call into action light and heat, illuminate and promote chemical decomposition and combination, magnetise steel, alter colours and develop them in plants, and advance many of their characteristic qualities, and all this mechanically, or by vibratory action. Yet, whatever be the difficulties when we suppose light to consist of material particles, we are compelled by its properties, to admit that light acts as if it were material, and that it enters into combination with bodies, in order to produce the above effects.

Were it not for the scattered rays of light, and those of emission after excitation from absorption, no object would perhaps be visible out of direct sunshine; every shadow of a passing cloud must cause pitchy darkness, the stars would be visible all day, and every apartment into which the sun's rays had not direct admission must be involved in nocturnal obscurity. This scattered action in the atmosphere on the solar light, is greatly increased by the irregularity of temperature caused by the same luminary in its different parts, which, during the day-time, throws it into a constant state of undulatory action, and by thus bringing together masses of air of unequal temperatures, produces partial reflections and refractions at their common boundaries, by which much light is turned aside and directed to the purposes of general illumination.—(Herchel's "Astronomy," p. 33.)

157. *Characteristics of Light and Heat.*—Black mica, obsidium, and black glass, as before stated, are nearly opaque to luminous rays, but they allow 90 per cent. of radiant heat to pass through them, whereas a pale green glass covered with a layer of water, or a very thin plate of alum, will, although perfectly transparent to light, almost entirely obstruct the permeation of heat-rays. From the foregoing we arrive at the fact that heat and light may be separated from each other;

and if we examine the rays of the sun by that analysis which the prism gives us, we shall find that there is no correspondence between intense light and ardent heat.

158. *Further proofs that all bodies continually throw off or undulate their properties, and thus can image themselves on certain surfaces, both in darkness and especially when under the influence of light.* In the Daguerreotype process, those parts of the iodised silver plate upon which the light has acted with most energy, receive, when the plate is exposed to the vapour of mercury, the largest quantity of that vapour over their surfaces, and the gradations of light are marked very beautifully by the thickness of these mercurial films. Now, if we write with a piece of steatite (soap-stone) on a looking-glass, the writing is invisible until we breathe upon it, when it appears distinctly. If we place coins on a plate of glass, and allow them to remain for a time in contact, although no change will be visible when they are removed, we may bring out beautiful images of the coins, &c., by breathing on the plate, or exposing it to any vapour. Further, we may first breathe uniformly over the whole plate, and then write on it with any substance; the characters will become visible whenever the plate is again breathed upon, and this phenomenon lasts for some time. Not only is glass applicable to this purpose, but every other polished body exhibits the same appearances; it has been tried with metals, resins, wood, pasteboard, leather, &c. Even fluids may be used; thus, if we take a clean and still surface of mercury, hold over it a body, and breathe on the other parts, or what is better, breathe on the whole surface first, and then remove the moisture by any gentle means, from particular parts, they will again become visible when breathed upon, even after several days, if the mercury remains undisturbed.

Moreover, absolute *contact* with the extraneous body *is not necessary, mere juxtaposition* producing similar effects. If we hold over a polished body a screen, part of which has been cut out according to pleasure, but without allowing it to touch, and then breathe on the whole, and allow the moisture to evaporate, we shall, on breathing on it again, be enabled to distinguish fully the figure of the excised parts, and still further, it does not require a polished body, inasmuch as *dull* glass exhibits the same phenomena. These appearances were produced in a great many ways. For instance, an engraved metallic plate was warmed, and then held for half a minute on a well-polished piece of silver foil or clean mirror plate. When these substances became cold, they were breathed upon, and exhibited the above mentioned aspects in a much more perfect manner: for not only were the outlines of the body visible, but also the individual figures, letters,

&c., and all with the greatest distinctness. Frequently silver or other metallic surfaces were made warm, and then cold bodies, variously cut stones, figures of horn, pasteboard, cork, coins, &c., were allowed to remain on them for some time. The phenomena were all the same; thus, mercurial vapour was found to act like the vapour of water, and the vapour of iodine after the manner of mercury. An iodised silver plate, having some of these bodies placed upon it, was introduced into the vapours of mercury, and then the perfect image became visible, that is to say, *Daguerre's phenomenon was produced without the intervention of light, for the experiments succeed just as well by night as by day.* Moser argues from these experiments, "*that contact is capable of imitating the action of light*,"* and he considers the following experiments to prove this clearly: a silver plate was iodised during the night, and even without the light of a candle; a cut slate of agate, an engraved metallic plate, a ring of horn, &c., were then laid upon it, and the plate was afterwards introduced into the vapours of mercury. A good clear picture of all the figures, of the stones, the letters of the plate, and of the ring was obtained. A plate which had been treated in the same manner was exposed to day or sunlight, and similar pictures were produced. Other plates of a like kind were placed beneath coloured glasses—yellow, red, and violet; under the first two only a trace of the image was evident, but beneath the violet it was clearly defined. Upon these experiments, Moser remarks, "the *violet rays continue the action commenced by the contact.*" A new plate of silver was cleaned and polished, then a surface with various excised characters was suspended over it without touching, and the whole was exposed to the sun for some hours; after the plate, which of course did not exhibit the least change, had been allowed to cool, it was held over mercury heated to about 60° Römer, a clear image of the screen was produced; those parts where the sunlight had acted, caused the deposition of a quantity of mercury. Plates of copper and glass were treated in the same manner, and with similar results. If we compare the remarkable fact of the action of light upon surfaces of silver with the above-mentioned phenomena produced by contact, we can no longer doubt that light acts on all bodies, modifying them, so that they behave differently in condensing the vapours of mercury. Moser then proposes the following general expression of the fact: "*Light acts on all bodies; and its influence may be tested by all vapours that adhere to the surface, or act chemically upon it.*" Further "*that when two bodies are sufficiently approximated, they reciprocally depict each other.*"

* Light only gives energy to the undulating properties always escaping from bodies.

159. The galvanic action set up by the contact of two dissimilar metals, and also the operation of heat, incites bodies to print or impinge, with different degrees of intensity, by undulatory action, their properties and images on all proximate surfaces, especially when within, as before noticed, what has been called, "striking distance." These impressionable phenomena appertaining to ponderable objects have been many times noticed and described by my clairvoyants. These images, say they, sink deeply into all adjacent bodies, and even very frequently permeate them. I have very many times in my life requested different persons to breathe over a piece of paper or any other substance, and I have, at varying subsequent periods, presented these surfaces to certain seers, who separately and distinctly described, and sometimes named, the parties that had breathed over the objects in question. In fact clairvoyants state, that everything which touches or even comes near another body, always, and under most circumstances, imprints a distinct image of itself, and receives in turn a picture of the substantive existence it came near, or in contact with. These results were very erroneously supposed by Moser to be effected by "invisible light," and by others as produced by "latent heat." (See Section 51.)

160. Upon repeating some of the foregoing experiments of placing a disc upon a metal plate and breathing thereon, it is necessary, for the production of a good effect, to use *dissimilar* metals, thus setting up Meloni's galvanic action. For instance, a piece of gold or platinum placed on a plate of copper or silver, will make a very decided image, whereas copper or silver on their respective or like plates, gives but a very faint one, and bodies which are bad conductors of heat placed on good transmitters, make decidly the strongest impressions when thus treated.

161. *Experiments with heat, or Thermography.* On a well-polished copper-plate were placed a sovereign, a shilling, a large silver medal, and a penny. The plate was gently warmed by passing a spirit-lamp along the under surface; when cold, the plate was exposed to the vapour of mercury. Each piece had made its impression, but those produced by the gold and the large medal were most distinct, the letters even being copied.

162. With a view of ascertaining the distance from each other at which bodies might be copied in the *dark*, there was placed upon a plate of polished copper a thick piece of plate glass, over this a square of metal, and several other things, each being larger than the body beneath. These were all covered by a deal box, which was an inch distant from the plate. The things in question were left in this position for the night. On exposure to the vapour of mercury, it was

found that each article was copied, the bottom of the deal box more faithfully than any of the others, the grain of the wood even being imaged on the plate.

163. M. Moser proposes that, "we have most positive evidence that all bodies are *constantly* radiating some particular and energetic principles from their surfaces." "It is through these emanating elements that the various productions of the spectral images in question are due." (See Section 51.)

164. My own results, says Mr. Hunt, would show, that the electro-negative metals make the most decided images upon electro-positive plates, and *vice versa.* I have also, he continued, found that the electrical discharges have the remarkable ability of restoring impressions which have been long obliterated from the plates by any polishing process; proving, in a very convincing manner, that the disturbances upon which these phenomena depend *are not confined to the surface of the metals employed*, but that a very decided molecular change has been effected *for a considerable depth into the mass.* The magnetic undulations, always emanating from the load-stone, like those of other substances, are known to have the ability of permeating a table or even a wall, as perceived whilst acting, through these interceptions, upon a piece of iron situated in the abdomen of the floating swan, placed on the water contained in a basin; this toy-bird is seen to follow the movements of the magnet.

165. If we cover a copper plate with water or oil, to the depth of 1-16th of an inch, and support, upon bits of glass, a medal, so that its under surface just touches the fluid, a very decided image is made upon the copper plate in a few hours. These images are partly visible by the tarnishing of the plate over every part but that which is covered by the medal. Upon pouring off the fluid, and dry-polishing, the image is rendered invisible; but on exposing the plate to vapour, it is again brought out.

166. We have now seen, writes Mr. Hunt, that *light*, *heat*, *machine-electricity*, and a *voltaic current*, all produce that disturbance upon the surfaces, at least of solid bodies, which disposes them to receive vapours upon definite spaces. It will also be found that any mechanical disturbance to which the plates may be subjected will act in precisely the same manner as the above elements.

167. *Further touching the prismatic spectrum.* Herschel showed that the largest quantity of solar heat was manifested in the least refrangible rays, and particularly in beams which were not visible to us. He also proved that the maximum of luminous ability was found in the yellow ray. Ritter demonstrated that invisible rays of great refrangibility had a large amount of chemical energy, and Seebeck

pointed out that this tendency to produce change was confined to these and the blue rays. It was long the custom to consider the prismatic spectrum as divisible into three classes of rays: the red, or calorific beams; the yellow, or luminous rays; and the blue or chemical beams. All coloured rays may be regarded as tinted *luminous beams*, differing in the intensity of their effects, but still distinct from the rays of light. What is commonly called a beam of light consists of four distinct imponderable material principles—as light, heat, colour, and chemical rays, &c., &c. The chemical influence is not only co-extensive with the luminous rays, but it occupies a space considerably beyond these beams. Sir John Herschel distinctly traced the calorific energy through all the luminous rays and much below them.

168. *On the existence of colours in everything.*—Melloni supposed all bodies, even a white sheet of paper, to have an invisible "chemical colouration." Thus we find that coloured media allow the passage of a larger quantity of the rays of their own particular tint than of any other. We also find that colourless fluids admit the permeation of the chemical influences of the solar beam in very different degrees. Hence M. Melloni argues, that according to his "chemical colouration" of the fluid, so is its permeability to different rays which produce chemical change. According to Frisnel a pencil of solar rays is the union of an infinite number of rays of different refrangibility, each ray arising from undulations of the material ether, not having the same velocity. Secondly, that by refracting a pencil of solar rays through a prism, we have the solar spectrum, which possesses different properties on account of its dissimilar action on external bodies. (See article "Colour.")

169. It is now established that the sun's rays cannot fall upon any body without producing a molecular disturbance, or a chemical change. Wherever a shadow falls, a picture is impressed. It matters not, whether the material which receives the images be one of those chemical compounds which are so susceptible of change, or a plate of metal, or a block of stone. The surfaces of all material things are constantly, whilst under the influences of sunshine, undergoing a *mysterious** change, which is communicated by molecular vibrations, even to the entire mass, and new conditions are established, which, with all the abilities of chemistry, we cannot yet follow.

170. Electricity and magnetism have been found to act on photographic papers after the manner of light, and in this way can produce electrographs.

171. *The luminosity of the common magnet.*—Baron Reichenbach,

* See Sections 17 and 51.

speaking of one of his paralytic patients (Miss M. Maix, aged 25), who was otherwise in a natural healthy state, relates that she could, when in the dark, perceive luminous rays—about a hand's breadth in height —always emanating from the poles of large magnets. When this lady became attacked with spasms, the magnetic light increased most extraordinarily to her eyes or perceptive faculties. She then noticed rays of light flowing from all parts of the steel magnet, weaker than at the poles, but still spread universally over the whole horse-shoe magnet. Another person, a Miss Nowotny, and other patients, recognised the same dazzling brightness over the loadstone and different magnets. These ladies saw luminous rays, not only in darkness, but in a very dim light, where objects were scarcely perceptible to other persons. The certainty which we possess that the *aurora borealis*, is formed under the influence of the magnetic poles of the earth, joined to the facts now revealed, that although invisible to eyes in general, coloured (especially white, yellow, and red) emissions of light do issue from magnets, lead us to surmise that the *aurora* is either actually the magnetism itself issuing from the polar regions, or else a direct effect of it.

The undulatory properties of bodies intensified by sunlight.—Baron Reichenbach continually noticed that his patients could recognise by their feelings persons and things that had been recently exposed to the solar rays. Thus Miss Reichel and others, says the Baron, were found always to experience great increase of energy from the touch of my hand after I had been in the sunshine, which, it would appear, imbued me with an ability, like that conveyed to Professor Endlicher, when charging him with magnetic fluid by passing a magnet over his body—as recognised by Miss Nowotny.

"After I had given up the experiments with the sun's rays on Miss Maix," continues the Baron, "the girls of her neighbourhood amused themselves with similar operations. When I at a future period revisited this lady, they told me that my patient discovered an iron key, which had been laid in the sunshine for a short period, and had, she thought, become magnetic, resembling the bar magnet they possessed. The key did not, however, attract iron, but Miss Maix declared it acted on her like a magnet. The key had therefore acquired a magnet-like charge from the sun. This property did not endure, but disappeared from the key after a period." The foregoing circumstance led the girls to further experiments, with astonishing results. They took a horse-shoe magnet which had become very weak, and instead of rubbing to strengthen it, laid it in the sunshine, and they had the pleasure to see their expectation fully confirmed. The magnet became so much strengthened and magnetically effective upon the

patient, that whenever a magnet became weak, it was only necessary to lay it in the sun to restore its pristine ability. Zantedeschi's experiments were thus confirmed.

The magnetic action of crystals and their emanating light were enhanced after the same manner—by exposure to the sun—as were the undulatory qualities of all other bodies, as exemplified by their effects after being exhibited to the sunbeams. These varying results could be transmitted like sound by means of metallic wires or through wooden rods, the bodies exposed to sunlight being attached at one end, and the other extremity placed in the hands of the Baron's patients. These latter results ensued when bodies were exposed to the moon's rays, as perceived by Miss Reichel.

172. *Mirage.*—When the sun calls into action heat over an expanse of sand, the layer of the atmosphere in contact with the said sand becomes lighter and less refracting than the air above it, consequently rays from a distant object striking very obliquely on the surface of the heated stratum are often totally reflected upwards, producing images like those caused by water: hence the mirage of water in the desert, houses and ships in the air, &c.

No physical ability or energy can be conveyed from one locality to another without a ponderable or imponderable material vehicle Young supposed that the whole universe, including the most minute pores of all material bodies, whether solid, fluid, or gaseous, are filled with a highly elastic rare medium of a most attenuated nature, called ether (the unparticled or undeveloped matter of the moderns), possessing the property of *inertia* (inactivity), but not of gravitation. This *ether* is not light, but light is manifested in it, through the excitation of luminous bodies, by means of an electric or magnetic vibratory movement, similar to the undulations of water, set in wave motion by thermal disturbed winds, &c.

Light forms only part of the atmosphere of the sun, and extends throughout the ultimate elements of matter or the unatomised *ether* of the Schools, and also throughout our aërial element and the world's every constituent. Light does not actually travel bodily from the sun, but its emanating pulsatory effects run their course like waves along an excited rope.

174. *Cause of blueness of the sky.*—It is the polarisation of light (as when it is rendered incapable of refraction and transmission in certain directions) that produces the blue vault that spans the earth on a sunny day.

175. *Diffusion of luminous rays.*—Pure air, as before noticed, cannot scatter the light, which chiefly makes objects visible to our senses. This dispersion is effected not by molecules or atoms, but through

certain particles, copiously spread throughout the air we breathe. This illuminated dust is found to consist of living and dead substances; for instance, there are points or fragments of straws, shreds of wool, cotton, and thread, the pollen of flowers, the spors of fungi, with bactria, and the germs of many other things, also rays of smoke, &c., &c.

Further, the sun would appear to the inhabitants of the earth only as an intense light in a dark, black ground, if our globe was not surrounded with the various strata of air, in which are placed clouds and vapours that collectively reflect and assist in scattering the light that extends from that great orb which divides the day from the night.

The sun has probably three different strata surrounding it, one of which envelopes and lies in contact with its body, and is called the cloudy stratum; next and above this, is the luminous zone, supposed to be the source of heat and light; the third and last envelôpe is of a transparent gaseous nature.

The Effects of Light on Ponderable Matter.

176. The actinic or chemical rays contained in the atmosphere were intercepted by Mr. Hunt from certain cress seed exposed to the full influence of light and heat. The seed for several days showed no signs of germination; in fact, seeds actually placed in the dark sprouted earlier than those situated in the light. The remarkable fact was thus developed, that the luminous principle is actually inimical to the excitation of vitality in seed. Many investigations proved that the germination of seed is more rapid under the influence of the actinic rays separated from the luminous ones, than it is under the sway of the combined radiations, or in the dark. Seed, buried deep, out of the sphere of actinism, and also excluded from the air, will not germinate. Again, seed simply strewn over the surface, exposed to the glare of day, is a long time sprouting, but when placed a little below the surface, where the luminous rays have lost their ability and the actinic energy still penetrates, and where air, moisture, and warmth exist, germination goes on actively.

177. Hydrogen and chlorine will not combine in the dark, but they unite, and even explode, in the light. If a solution of peroxilate of iron be kept in the dark, no action ensues, but when exposed to light an infinite number of gaseous bubbles are seen to rise, as if caused by fermentation, a descending and ascending current takes place, and it becomes gradually yellowish, then turbid, and eventually precipitates as protoxilate of iron, in the form of small brilliant crystals of a luminous yellow colour. It would appear that certain

bodies are capable of absorbing the actinic rays, and then behaving in the dark as if exposed to sunlight. Pure chlorine gas, when placed in the sun's rays, seems as if it absorbed the actinic principle, for now, when mixed with hydrogen, the two unite if deposited in the dark. The actinic influence acts on the earth and rocks, no less than upon the animal and plant. Metals, glass, marble, &c., after having been exposed to sunshine, will, when presented to the action of mercurial vapours, exhibit the fact that a disturbance of some kind has taken place upon the portions illuminated, whereas no change can be detected on the parts kept in the dark.

178. Most persons must have observed the difference between *vegetables* thriving in solar light and those which grow in obscure situations, or are entirely deprived of its agency. The fórmer show brilliant tints; the latter, by a process of etiolation or blanching, become dingy and white. In the one, the various secretions, or rather creations, come to perfection; in the other, they are either modified or disappear, as we see with celery cultivated for the table. The rosy sides of fruits depend upon exposure to the sun. Plants grown in the dark are not recognisable as to form, &c., until after exposure for a time to light. The animal creation under the influence of light is equally evident, as seen in the dull and dingy tints of polar and subterranean creatures when contrasted with the gaudy and brighter colours of those which inhabit tropical regions. In the human species a due quantity of light is requisite to health. Thus miners are pallid and unhealthy, like the inhabitants of the alleys and courts of cities.

179. *Chemical effect of Light.*—If a leaf is laid upon a sheet of *calotype paper* it will take an impression in twenty to thirty minutes from simple exposure to moonlight, not concentrated by a lens. Some of the salts of gold and silver, especially their chlorides, are very susceptible tests of the agency of light. If a piece of paper be dipped in a solution of nitrate of silver and kept in the dark, it suffers no apparent change; but if exposed to light, it soon becomes purple, brown, and black, through chemical changes.

Further regarding Vegetation.—During certain periodical cycles, light excites an action in the buds of plants, thus inducing the circulation or flow of the sap.

Organic tissues.—According to Berzelius, the green colouring matter of plants is readily decomposed by light into three different substances: one *yellow*, another *blue*, and a third *black;* and according to the proportion of these three mixed together, different kinds of green must be produced. If a tincture of pure chlorophyl (the green colouring matter of leaves) be exposed to the action of the sun, the

green tint becomes in a few hours converted into yellow, for decomposed chlorophyl yields a blue colouring matter. Again, the influence of light will convert starch into chlorophyl. Every part of an amylaceous (partaking of the nature of starch) root, becomes green on exposure to the luminous rays. In autumn, as the green colour decreases, the starch also lessens, and finally cannot be detected by the iodine test. If a plant which is actively transpiring and absorbing under sunshine be carried into a dark room, both these operations are almost immediately checked, even though the surrounding temperature be higher than that to which the plant was previously exposed. The influence of light upon the direction of growing parts of plants, also the opening and closing of flowers, &c., is probably due to its share in the operations already detailed; thus the green parts of plants, or those which effect the decomposition of carbonic acid—or rather formation or creation of carbon—have a tendency to grow towards the light, whilst the roots have an equal propensity to avoid it. That the first direction of the stems and roots of plants is very much influenced in this manner, appears from the fact that by reflecting light upon germinating seeds in such a manner as that it shall only strike upon them from below, the stems are caused to direct themselves downwards whilst the roots grow upwards.

The sun produces freckles or brown pigment cells in exposed parts of the human skin. The Portuguese Jews who settled at Tranquebar 300 years ago are as dark as the native Hindoos. The birds from tropical climates lose their brighter tints in this country. If certain insects, which naturally inhabit dark places, be reared in an entire seclusion from light, they grow up almost as colourless as plants that are made to vegetate under similar circumstances. The appearance of animalcules in infusions of decaying organic matter, is much retarded, if the vessel be altogether secluded from light. The rapidity with which the water-fleas, &c., of our pools undergo their transformations has been found to be much influenced by the amount of light to which they are exposed. If one parcel of an equal number of silkworms' eggs be preserved in a dark room, and the other modicum be exposed to common daylight, a much larger proportion of larvæ are hatched from the latter than from the former. Dr. Edwards has shown, in the case of tadpoles, that if they are deprived of light the growth continues, but their metamorphoses into the condition of air-breathing animals is arrested, and they remain in the condition of large tadpoles. Light, in conjunction with good food, promotes health, assists in curing disease, and prevents deformity.

180. *Light has a positive influence upon most things, especially the organic.*—The chemical changes which light causes to take place in

the vital principles are many and varied. Who does not know the efficacious effects of light upon the feelings; of its pleasurable and sometimes uncongenial action upon the nervous system, and likewise the spiritual principle? The chemical ability of luminous rays are wonderful. What a surprising difference between the darkness of night and the light of day! When the sun arouses into action Nature's every element, as he sheds abroad his inextinguishable effulgent light, over the mountains and valleys of creation, what indescribable delight, when bathed with his influence, does the harmonious individual experience! If the human spirit is deprived of that light which emanates from visible substances and orbs in being, it will soon desert the organism and leave it to perish in the dark, cold, negative conditions, or else it will struggle to maintain the system in the most inharmonious and diseased state.

181. *Vegetable Light.*—Many flowers, especially those of an orange colour, such as the sunflower, oriental poppy, marigold, nasturtium, &c., disengage light in serene and warm summer evenings, sometimes in the form of sparks, and at other periods with a steadier but more feeble glow. Light is also emitted by certain species of fungi, especially those which grow in moist warm places where light is entirely excluded, as in the depths of mines. The light is perceived in all parts of the plant, but chiefly in the growing white shoots. It sometimes ceases if the vegetable be deprived of oxygen or certain other constituents of the earth's atmosphere, either by being placed in a vessel from which the air has been exhausted, or in some other gas having no oxygen in it, as nitrogen, &c., and it re-appears when the plant is restored to air. No natural active luminosity is perceived after the death of the plant. An evolution of light has also been observed to take place from decaying and dead wood of various kinds, particularly that of roots, and also from fungi whilst decomposing. This corresponds with the luminousness of certain animals after their decease. The lucidity of the nasturtium would appear to be sometimes due to the absorption of light and its subsequent liberation, for if it be plucked during sunshine and carried into a dark room, the eye after it has reposed for a short time, will perceive the flower by a light emitted from its leaves. The foliage of the *œnothera macrocarpa* exhibits a kind of phosphoric light when the air is highly charged with electricity. The fungi of the olive grounds are luminous at night, but they exhibit no light even in darkness *during the day.* The subterranean passages of the coal-mines near Dresden are illuminated by the light of a peculiar fungus, the *rhizomorpha phosphoreus.* On the leaves of the Pindoba palm a species of agaric grows, which is exceedingly luminous at night; and many varieties

of the lichens creeping along the roofs of caverns, lend to them an air of enchantment by the soft and clear light they diffuse. In a small cave near Falmouth this luminous moss is very abundant. A plant which abounds in some of the jungles of the East Indies was sent to this country, and although dead, was remarkably luminous, and when living, the light which it emitted was very vivid, lighting up the ground for some distance—the result, no doubt, of a peculiar electric manifestation. A Belgian botanist reports from Nicaragua, that he has lately discovered a luminous plant which is gifted with the ability of giving a most energetic electric shock, especially from the points of its leaves.

182. *Animal Light, or the evolution of luminous rays from living creatures.*—A large proportion of the lower classes of aquatic animals possess, in a greater or less degree, the ability of emitting light. The phosphorescence of the sea, which has been observed in every zone, but more remarkably between the tropics, is due to this cause. When a vessel ploughs the sea during night, the waves, especially those in her wake, exhibit a diffused lustre, interspersed, here and there, by stars or ribands of more or less brilliancy. These latter are due to the larger animals. This interesting phenomenon, when it occurs on our coasts, is chiefly produced by a globular form of these creatures, about the size of pins' heads, like grains of boiled sago. The light would seem to proceed from the nature of the *mucous* which covers them, for this, when removed, retains its properties for some time, and may communicate them to water or milk, rendering these fluids, when they are warmed and agitated, luminous for some hours. If friction be applied to these animals, a fresh quantity of the secretion is perhaps formed, or brought into contact with air, which seems sometimes necessary to maintain, or call into action, this light. Besides the *Acalephæ* (so called from stinging like a nettle) which tenant the deep, we have many of the *Polypifera*, which are luminous in an inferior degree, and also some of the *Echinodermata* (having skins covered with tubercles or spiculæ) which are likewise phosphorescent. Of the lowest class of *Mollusca* (from *mollis*, soft)—the *Tunicata*, or headless mollusks—a very large proportion are luminous, especially those which float freely through the ocean, and abound in the Mediterranean and tropical seas. Among some of the shell-bearing molluscs the phenomena may also be observed, and likewise in the marine *Annalidæ*. Other oceanic animals have similar properties; thus the *Crustacea* (from *crusta*, a hard covering), especially the minuter species, are known to emit light in brilliant jets. The luminous matter appears to be a secretion, or a creation, taking place on the mucous surface of these animals.

183. *Luminous Insects.*—These light-giving invertebrate (spineless) creatures are most numerous among the Beetle tribe, and are nearly restricted to two families, the *Elatoridæ* and the *Lampyridæ* (glow-worms). The former contain 30 luminous species, which are known as *fire-flies.* These are all natives of the warmer parts of the New World. Their light proceeds from two minute but brilliant points, which are situated on each side of the front of the thorax or chest, and from another place beneath the hinder part of the thorax. The light proceeding from these points is sufficiently intense to allow small print to be read in the profoundest darkness. In San Domingo the natives use these insects instead of candles, and tie them to their feet and heads, when travelling at night, to give light to their path through the forest. In all the luminous species of this class, the two sexes are equally phosphorescent. The family *Lampyridæ* contains about 200 species; the greater part of these are natives of America. Among the larger number, the luminosity is most strongly displayed by the female, which is usually destitute of wings. The light of the glow-worm issues from the under surface of the three last abdominal rings. The luminous matter, which consists of phosphorescent granules, is contained in minute sacs, covered with a transparent horny lid; and this exhibits a number of flattened surfaces, so contrived as to diffuse the light in the most advantageous manner. The sacs are mostly composed of a close net-work of finely divided air-tubes, which ramify through every part of the granular substance; and it appears that the access of air through these is thought to be a necessary condition of the phosphorescence; for if the aperture of the large trachea, or wind-pipe, which supplies the luminous sac be closed, the light ceases; but if the phosphorescent pouch be lifted from its place without injuring the trachea, the light is not interrupted. All the luminous insects appear to have the capacity of extinguishing their light. Other insects, not included in the above, possess luminous abilities, as the *Fulgoræ* (from *fulgor*, an effulgence) or lantern-flies, natives of Guiana and China. One of our centipedes, found in dark, damp places, beneath stones, is slightly luminous, and the common earthworm is also said to be phosphorescent at the breeding season. This light is more brilliant with certain insects during the period of the exercise of the reproductive functions than at any other, and is then exhibited by animals which do not manifest it at any other period. Some moths are often faintly luminous. Many fish have the ability of throwing out momentary vivid flashes of light. It not unfrequently happens that an evolution of light takes place from the bodies of animals soon after their death, and even before decomposition has set in. This has been most fre-

quently observed to proceed from the bodies of fishes, mollusca, and other marine tribes; and also evolved from the surface of land animals, and even from the human body. A considerable amount of light has often been seen to be given off from the faces of living individuals who were near their end.

The whole body of some fire-flies is phosphorescent, and when rubbed upon the human skin, illumines it. This fact shows that light can be divided into parts, and also testifies that it is a portable imponderable material principle.

184. There are several of the smaller *Anellidæ*, or marine worms, which are brilliantly luminous when irritated, the luminosity having the character, however, of a succession of sparks, rather than of a steady glow. It appears from recent experiments, that this peculiar luminosity is the especial attribute of the muscular system, and that it is produced with every act of the muscular contraction in these animals, and may depend upon electrical agency. Luminousness of the surface is sometimes witnessed in disease. Thus a case is recorded by Dr. Carpenter, in which a large cancerous sore of the breast emitted light enough to enable the [hands on a watch-dial to be distinctly seen when it was held within a few inches of the ulcer.

185. The phosphorescence of the sea in part owes its origin to a countless host of infusorial animalcules, and among them are the *Mammaria scintillans*, which offers the beautiful spectacle of, as it were, the starry firmament reflected by the surface of the sea. There are also luminous silicious (flinty) shelled infusoria, and likewise the light-flashing ciliated (hairy) animalcules of the cuirassed monads, the *Proracentum micans* (glittering), and a species of *Rotifera*, chiefly found in the Baltic sea. The flashing of these creatures is renewed by stimulation. Ehrenberg found in the organs of the photocaris (which emits flashes of light either at pleasure or when irritated or stimulated) a cellular structure with large cells and gelatinous interior, resembling the electric organs of the gymnotus and the torpedo. When the photocaris is irritated we see in each cirrus (curl) a kindling and flickering of separate sparks, which gradually increase in intensity until the whole cirrus is illuminated, and at last the living fire runs also over the back of the small nereis (nymph)-like animal, so that it appears under the microscope like a thread of sulphur burning with a greenish yellow light. In the *Oceania* (*Thaumantius hemisphærica*) the number and situation of the sparks correspond exactly with the thickened base of the larger cirri or organs which alternate with them. The exhibition of this wreath of fire is a vital act, and the whole development of light is an organic vivifying process which

in the infusoria shows itself as an instantaneous spark of light, and is repeated after short intervals of repose. According to the foregoing facts the luminous creatures of the ocean show the existence of a magneto-electric light-evolving process, in other classes of animals besides fishes, insects, mollusca, and acalephæ. Further, it might be asked, Is the secretion of the luminous fluid which is effused in some phosphorescent creatures, and which continues to shine for a time *without any further influence of the living animal* (as exemplified relative to the secretion of the *Lampyridæ* and *Elateridæ*, or luminous leaping beetles, also in the German and Italian glow-worm, and likewise in the South American cucuqo, which lives on the sugar-cane)—is, we repeat, this persistent luminosity a consequence of the first electric discharge, or is it simply dependent on chemical effects or resident portions of inherent light? The shining of insects surrounded by air has perhaps other physiological causes than those which occasion the luminosity of the inhabitants of the water, as fishes, medusæ (sea blubber), and infusoria. "In addition, the small animalcules of the ocean, being surrounded by strata of salt-water, which is a good conducting fluid, must be capable of great electric tension of their light-flashing organs to enable them to shine so intensely in the water. They strike like torpedoes, gymnoti, and the tremola of the Nile, through the stratum of water, while electric fishes, in connection with the galvanic circuit, can decompose water and impart magnetism to steel bars. The foregoing economy make it probable that it is one and the same process which operates in the smallest living organic creatures, also in the combats of the serpent-like gymnoti, the flashing, luminous infusoria, which raise the phosphorescence of the sea to such a degree of brilliancy, as well as in the thunder-cloud, and the auroral, terrestrial, or polar light (silent magnetic lightnings), which, as the result of an increased tension in the interior of the globe, are announced for hours beforehand by the suddenly altered movements of the magnetic needle."—Humboldt's "Aspects," vol. ii., p. 57.

Sometimes we cannot, even with the highest magnifying abilities, discern any animalcules in luminous waters, and yet, whenever the wave strikes and breaks in foam against a solid body, a light is seen to flash. In such case the cause of the phenomenon probably arises from the light resident in or upon the decaying animal fibres, which are disseminated in immense abundance throughout the great body of water. If this luminous fluid is filtered through fine and closely-woven cloths, these small fibres and membranes are separated in the shape of shining points. After bathing in tropical seas, the naked body continues luminous for a time, from the shining organic particles which adhere to the skin. If a board be rubbed with a portion of the

gelatinous *Medusæ hysocella*, the part so treated regains its luminosity on friction with a dry finger.

The luminous property of the *Lampyridæ* (glow-worms) is confined to the terminal segments of the flattened abdomen, which differ in colour from the rest, and are usually yellowish or whitish. This character is peculiar to the true glow-worms, and announces their phosphorescence. The light diffused by the *Lampyridæ* is of a lambent, electric greenish colour; the insect can vary or suspend its luminosity at will. The light emitting segments preserve their peculiar property for some time after being separated from the rest of the body, and manifest it even *in vacuo*, or when immersed in gases which are *not supporters of combustion*.

186. The quantity of light emitted by putrescent animal substances does not arise from the greater degree of decay in such bodies, as is commonly supposed, but, on the contrary, they begin to shine some time before any apparent signs of putrefaction take place, and the greater the putrescence the less the measure of light emitted. Light is a chemical element, and forms part of the constituent principles of most bodies, particularly of marine fishes; and it may be separated from them by a particular process, or be retained and rendered permanent for some time. The experiments from whence this inference is derived were made with pieces of herrings, mackerel, and living tadpoles immersed in solutions of Epsom, Glauber's, and sea salts, in all of which a quantity of light was manifestly imparted to these saline menstrua which the latter, under various circumstances, retained for a considerable time. These experiments prove that light is not partially, but wholly, incorporated with every particle of the animal substance. It is probably the first elementary principle that escapes after the death of fishes; and the putrescence is by no means promoted, but rather retarded, by this emission of light. Some bodies have the quality or ability of extinguishing spontaneous light when it is applied to them. These materials are water, both pure and impregnated with lime or carbonic acid, fermented liquors, ardent spirits, volatile alkalies, vegetable infusions, honey, &c., &c. When the spontaneous light is extinguished by some bodies or substances, it is not lost, but may be again revived in its former splendour by different saline menstrua. Spontaneous light is not accompanied with any degree of sensible heat discoverable by a thermometer. Cold extinguishes spontaneous light, but not permanently, since the light can be revived by exposing the substance to a moderate degree of temperature.

Effects of heat on light when in a state of spontaneous union.—In every substance there is a certain point of temperature at which it acquires its maximum of lustre. This varies considerably in different

substances. Thus fishes, rotten wood, and aqueous solutions become dark at a temperature of between 96 deg. and 110 deg., while glow-worms retain their lustre up to 212 deg. Common water impregnated with phosphorescent light, when, by mere time and rest, without any considerable change of temperature, it had become obscure, was soon rendered luminous when gradually heated by small and successive additions of warm water, but no sooner was boiling fluid added in any considerable quantity than the luminous appearance vanished and was altogether extinguished. It was here observed that if heat be applied to the bottom of a tube filled with illuminated water which has been some time at rest, the light will descend in phosphorescent streams from the top of the tube to the bottom and be gradually extinguished.

Effects of spontaneous light when applied to or mixed with different substances.—It was found on touching the luminous matter of fishes, the light adhered copiously to the fingers and hands, remaining very lucid for some time, but then gradually disappeared; whereas the same kind of matter, being applied to wood, stone, &c., at common temperatures, continued luminous for many hours. As to the animal fluids, the crassamentum or thickened part of the blood of healthy persons, as during inflammatory diseases, received the light of a herring, but did not retain it long; and when the coagulum had been kept for some time, and showed marks of putrescence, the light was more quickly extinguished. In some instances the light was ejected in globules, like quicksilver when rubbed with any unctuous substance, and afterwards adhered to the sides of the vessel in the form of a lucid ring. The serum (watery part of the blood) both of healthy and diseased persons retained the phosphorescent appearances longer than the crassamentum, and frequently recovered it when agitated. Urine (both fresh and stale) and bile showed little disposition to retain this light. Lastly, milk and cream, illuminated by mackerel-light, acquired great brightness and retained it for twenty-four hours; but when either of these turned sour they contracted a very extinguishing property, the light in some cases vanishing almost instantaneously.

187. The *Lampyris noctiluca*, or glow-worm, shines in its infant or larva (caterpillar) state, and also in the aurelian or chrysalis condition. The light exhaled from the full-grown animal is of a pale bluish-white hue, which is only emitted when the insect is moving either its body or legs. In some of the bogs of Ireland a worm exists which gives out a bright *green* light. The *Cancer fulgens*, a species of phosphorescent crab, is enabled to illuminate its whole body, and emits vivid flashes of light.

188. Phosphorescence is a rare phenomenon among aërial animals

of the higher class. But the great American bittern has the ability of emitting a light from its breast equal to the luminous rays of a torch. An emission of light takes place from the eggs of the grey lizard. The Surinam frog or toad is luminous, especially in the interior of its mouth.

189. *Spontaneous Combustion.*—Dr. M. Barry related to Dr. Carpenter the case of a clergyman who had a troublesome sore, occasioned by the combustion of phosphorus on the hand. Twice, at distinct intervals, this ulcer emitted a flame which burned the surrounding parts. It was particularly stated that ignition could not have been effected by any neighbouring flame.

190. Clairvoyants perceive luminous rays always proceeding from the ends of the toes and fingers of different persons, and especially is this apparent upon the heads of living creatures. The appearance of this lambent light escaping from the human brain was seen by these seers to vary as regards intensity and colour. Under disease it was often green and yellow, but when the subject was calm and in perfect health it was a beautiful blue tint. In olden times this luminous appearance was called the glory, and was often represented as playing over the heads of soothsayers and saints. Many persons in the common state of being are capable of perceiving light emanating from the heads of people when they were under excitement, and also from various animals, especially the feline race.

191. On reviewing some of the foregoing facts, I am incited to conclude that light is an imponderable *material element*, and in support of this opinion I would quote the following circumstances:—

(*a.*) Light resembles gravitating matter insomuch as it can be reflected and deflected, after contact, like a solid ball. Moreover, a luminous ray, similar to a strip of wood, may be split asunder, as in double refraction.

(*b.*) Luminous matter is capable also of being divided into distinct portable segments, for it may be applied, like fluids, to the surface of things and be perceptibly mixed up with gelatinous and other glutinous liquids, as if it were a pigment.

(*c.*) Light can likewise call forth or induce motion in ponderable bodies, like a mechanical agent, or that of the magnet acting on the needle, as exemplified in Professor Crookes' experiments.

(*d.*) Light can be united with certain ethereal entities, and thus aids in forming compounds, as where it combines with the elements of electricity, actine, heat, and colour rays, &c. It thus assists in constituting the so-called sunbeam. In addition it has been demonstrated that a ray of light can be distinctly separated from the foregoing principles.

(*e.*) Luminous matter is continually proved to be incorporated with all ponderable materials, as evidenced under the process of friction, percussion, condensation, and combustion, &c.

(*f.*) Light, like other elements, can have a being, or exist by itself without even the presence of heat, as exemplified in phosphorescent bodies. (See "Optics," secs. *e*, *s*, and *t;* and XI., Addendal Annotations.) There are many kinds of light (like there are varied hues and different electricities, heats, and magnetic elements—see these principles under their different headings), all varying in character as compared with each other. Thus we have—1st, the simple, pure pencils, as found in the sunbeam and diffused light mixed with heat, colours, and actinic rays, and also associated with unparticled matter and the magnetic and sonoro-electric fluids, &c. (See article on "Sound.") Further, we have—2nd, phosphorescent; 3rd, animal; 4th, vegetable; 5th, electric lights, &c., &c. By the employment of any of the above luminous rays the common eye is enabled to distinguish objects situated in darkness.

(*g.*) *Persistency of colours.*—It was *assumed* by Newton, and is still taught by natural philosophers, that the different hues of bodies are the result of the absorption of all the colours of light except the one reflected by the tinted object. I must, with all due reverence, beg leave to oppose this *theory*, and shall, I think, by the following facts, prove the impossibility of this source of coloration. It is well known that many blind persons can readily detect different hues, and even the variations of a given tint. Again, I myself, with thousands of others, have known clairvoyants, when miles away from the object—and again if the seer was placed in the darkest of rooms—pronounce the hues appertaining to different bodies. Further, the colours of objects have often been pictured upon certain sensitive surfaces, both in and out of the presence of light. These circumstances prove that colours are constantly *undulated*, both in darkness and in the presence of light from, or rather out of, the different tinted bodies that surround us.

(*h.*) It is well-known to the sensitive and capable colorist, that there are hundreds of different hues, and as many varying shades; yet when we dissect, so to speak, or decompose a ray of light, there are found only three positive colours, and, according to Newton, four complementary hues, which form the different tints described by this experimenter. But be it observed that these colours are not perceptible until the ray of light is decomposed. It might be assumed, and with truth, that common light merely serves to show us (by intensifying the constantly emanating undulating properties of bodies) the existence of the *innate* tints appertaining to the objects that surround

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NEW VIEWS

OF

MATTER, LIFE, MOTION,

AND

RESISTANCE:

ALSO

AN ENQUIRY INTO THE MATERIALITY

OF

ELECTRICITY, HEAT, LIGHT, COLOURS, AND SOUND.

To be Published Monthly.

BY

JOSEPH HANDS, M.R.C.S., &c., &c.,

Author of "Will-Ability," "Beauty and the Laws Governing its Development," "Homœopathy contrasted with Allopathy," "A Dissertation on Diets and Digestion," &c., &c.

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PRELIMINARY REMARKS.

It is intended throughout the forthcoming work to point out certain novel characters in regard to the influencing attributes of Matter—by displaying through particular facts—the true agency that the atomized and unatomized or ultragaseous worlds, exercise in the economy of Nature. Added to which, will be an investigation into some of the more abstruse Laws governing the various kinds of Motivity. Also an inquiry touching the action of the Life-Principle as it manifests itself, whilst governing the development of the vegetable and animal kingdoms. Further, the Materiality of Electricity, Heat, Light, Colours, and Sound, are considered, demonstrating that these principles have most of the characteristics of corporalities—save that of ponderability or weight. In addition, will be a disquisition touching the qualitative causes of Resistance, and lastly will be annotations on Geology and Astronomy.

LITERARY NOTICES.

We have been favoured with a perusal of a portion of Mr. Hands' Work on "Matter, &c.," and can speak of it as a most able and interesting contribution to scientific literature.—*The Modern Physician*.—May, 1879.

Mr. Hand's Essays on Matter, Motion, Life and Resistance, &c., are replete with instruction and original conceptions of a very striking character.—*Human Nature*.—June 20th, 1879.

Mr. Hands, of Hammersmith, author of some very interesting works, has now adopted the plan originated by Dickens and Thackeray, whose books were brought out in monthly instalments. Mr. Hands's views are most original and illustrated by facts, his language stimulates the mental taste, like that of Robert Burton and Dr. Johnson, and pleases whilst instructing the reader.—*The Sussex Daily News*.—June 18th, 1879.

Mr. Hands has issued the second (July) part of his "New Views of Matter, Life, Motion, and Resistance." In many respects, this thoughtful and industrious author has trodden paths which are also explored by Dr. Babbitt, in his great work on "Light."

These writers are pioneers in new fields of scientific research, and as such, a duty falls to their lot which cannot be attributed to a selfish motive. Mr. Hands is a true author, and gives to his readers profound original thought, at a popular price, his single object apparently being the education of the public mind in all its multitudinous forms.—*The Medium and Daybreak*, July 25, 1878.

us. We shall, then, presume that coloured bodies do not, in any way, reflect the hues resident in the sunbeam, but radiate their own *material* inborn tints. It is true that most objects can, and do, project the coloured rays given off from certain flames, when thrown upon their surfaces, so often demonstrated in our theatres and lecture-rooms; and here we find white surfaces appear as if dyed or painted, as they reflect the coloured rays thus thrown upon them.

(*i*). In continuation, it is stated in the schools, "that black bodies absorb all colours, and white grounds reflect them, and hence their appearance to the eye;" but if the colours in common light were free or sensible to our organisation, *white* bodies ought to become tinted, and be also capable of reflecting *these said light colours*, as they do those emitted during the combustion of certain metallised flames, in the way exemplified above.

(*j*). White and black, in common parlance, are said to be no colours, yet white and black surfaces possess as many diverse characteristics, as reds, yellows, and blues, &c. Moreover, black and white bodies are found to undulate their external distinctive qualitative appearances, after the same manner as the so-called tinted objects, and therefore we must come to the conclusion that white and black should be ranked among colours that signalise or belong to those bodies distinguished as being tinted.

In continuation. Black substances are no more capable of absorbing, and thus annihilating colours, than are those bodies that have white surfaces. Imponderable light merely serves to show the existence—in our general state—of the various hues we behold under its stimulating influence, as it does the being and places of the different ponderable things, with their outlines, that everywhere meet our vision. It would, in one sense, be as reasonable to *imagine* that gravitating bodies are developed by luminous rays, as that colours owe their *origin* to radiant light.

(*k*). Many solid white and black bodies, where they are decomposed or become separated into simple forms, testify to the fact that different colours *assisted* in making up their corporeal characteristics, as shown during the analysation of them; and so of a beam of light which is found to consist of, or be associated with, many imponderable elements (as simple luminous rays, colour beams, heat, magnetism, *actin*, electro-sonorous principles, metallised rays, and unparticled

or the ultra gaseous matter of Professor Crooks, &c., &c.), some of these we can detect and display by resolving—through means of a spectrum, &c.—a beam of light into its ultimate constituents.

(*l.*) It might, with advantage to our subject, be remembered, that as there are many very different kinds of reds, yellows, blues, &c., so also there are a multitude of characteristic black and white surfaces, all varying in appearance. Further, it is well-known that white fabrics can—by certain chemical processes—be made to assume numerous hues, which do not exist in or among the primary and complementary colours of the sunbeam.

(*m.*) A pencil of light can never be decomposed so as to display its compound colour-elements, &c., by being *cast upon* or simply *reflected* from the surfaces of bodies. To separate a luminous beam into its different constituents, it must be *split*, so to speak, into its various component rays, by permeating certain transparent fluids, or a clear solid substance, such as the diamond or a glass prism, &c. This last circumstance—as regards the colours in light—most positively proves that the hues we recognise as appertaining to tinted things surrounding us, are not the result of decomposed reflected light.

(*n.*) It has often been noticed that different artificial and natural colours produce varied strange impressions upon certain animals, and also affect some sensitive human beings. These results are likewise, at times, recognised by the blind, and also in particular diseases, and in the latter case, even in the dark, especially when the tint is brought near the patient. The results in question never ensue when these persons are acted upon by the colours (perhaps from their being so attractively combined) resident in common light. Of course, these sympathetic phenomena do not attach to colour-blind people, by reason that their phrenological organs, which appreciate varied hues, are too *diminutive* or too dormant and insentient, to measure the characteristic tints of different bodies.

(*o.*) In summing up the foregoing propositions, I would suggest the three following postulates:—1st. White bodies reflect the luminous rays thrown upon them, and also undulate from their surfaces—with other qualities—white radiations. 2nd. Black substances likewise throw back the beams of light falling on them, but they, at the same time, emit, with other properties, their innate dark undulations. 3rd,

Coloured objects also reflect the luculent rays cast upon them, but they, like black and white objects, radiate or throw off, from their exterior, with other properties, the tints that specially characterise them. All the above undulating emanations are constantly—whether in light or darkness—bursting from or out of, each distinct body, and these effluences can write their character on the nervous systems of animals and the life-principle of plants. Further, many of these pulsatory effluxes have been found capable of visibly depicting their bearings or characteristics, on sensitive surfaces or plates, and this, whether in the presence of light or in profound darkness.

DISSERTATION ON THE MATTER OF HEAT.

192. Caloric or the matter of heat is said by some philosophers to be a highly attenuated, imponderable subtle material element, the particles of which repel each other, but are attracted by surrounding bodies. The escape of caloric through space is called *radiation* of heat, and its communication by contact *conduction*. The term *specific heat* is applied to the quantity of thermometric (heat measuring) caloric required to raise different substances to the same temperature. Thus experiments prove that the quantity of heat which raises olive oil two degrees, will only elevate water one degree; hence a pound of water at 212° may be said to contain twice as much heat, or to have double the capacity for caloric, that belongs to oil. When heat changes the state or form of bodies, a large quantity disappears, and remains in them so long as they retain one form. To heat in this state of combination, and inappreciable by the thermometer, the term latent heat, or caloric of fluidity, has been applied.

193. Materials of every kind may be considered as possessing heat, which always forms one of their constituents, so that our most simple elements may, in this sense, be regarded as compounds, the matter of caloric pervading in a greater or lesser degree: the varied substantitive forms of which our systems are made sensible. Thus, when speaking of a solid simple object (iron for instance), we must regard it as consisting of metallic particles, each being surrounded with a halo or atmosphere of heat, and other imponderable elements, as electricity and magnetism, &c. This condition also holds with the molecules of all compounds, be they solid, fluid, or gaseous. Moreover, the simple and compound atoms of each body must be considered as being always in motion, and rotating on their polar axes (governed by association through the laws that rule over the planetary system), and accordingly as the revolution is increased or diminished, so will the states or conditions of matter ensue, designated solids, fluids, or gases.

The great natural agent heat can produce, in certain bodies, expansion, fusion, evaporation, thermo-electric currents, and many physiological phenomena; or at least these results accompany its absorption. Caloric may be unveiled or developed artificially by any means which propagate internal agitations to bodies—hence friction, hammering, percussion, sudden condensation, chemical combination, and electrical discharges evolve heat.

194. Heat radiates in straight lines in every direction from all bodies, and in this law of emanation it resembles light, its intensity diminishing in the same proportion as the sine of the angle of efflux. In addition, when bodies of different temperatures are brought near or associated with each other, they will all be found to radiate more or less heat, until their thermal condition is equalized, but the emission of heat-rays, &c., does not cease here, for it is one of nature's most peremptory laws, that *nothing* imponderable can be at rest. It then follows that the substances in question must continue to receive and give forth their ever motive caloric; therefore as each object, in their common state, receives a like quantity of heat, and of the same intensity as it gave off, their calidity, according to circumstances, must be equal.

When a metallic body is heated in a fire up to a certain degree, we have caloric unaccompanied by sensible light; but in the lunar rays, the light that is *supposed* to be originally transmitted from the sun, arrives at our planet without any sensible heat, even when collected in the focus of a burning-glass. Here the reflected heat (which is always very much less in quantity and intensity as compared with light) is incapable of rousing into a sufficient state of activity the caloric always resident in the earth's atmosphere, so as to give it the energetic motion that the sun's rays can call forth when influencing the imponderable constituents of the air; hence no doubt the deficiency of the result in question. In addition, it must be remembered that heat is never reflected or ejected with the intensity that light is.

(a.) As Regards Intensity.—People in general are often led to think and calculate more concerning the quantity of matter in motion than the vehemency of its transit. I would therefore draw their attention to the following facts:—If a twenty-pound ball be travelling at the rate of one mile an hour, it can only produce 1-20th the effect that it would if projected at the speed of 20 miles in the same time; or again, if a projectile, one

pound in weight, be moving twenty miles an hour, it must produce the same effect on the body resisting its course, as would a globe of twenty pounds weight if only journeying at the degree of one mile in a like period. (See article "Motion.") But to resume, not only may radient heat be collected in a focus by refraction through a lens, but also by reflection from a polished concave mirror. Thus, if we employ a pair of hollow specula or mirrors, and if a heated body be placed in the focus of one, and a thermometer in the focus of the other, the reflected heat falling on the bulb of the instrument will cause the mercury to rise; and conversely, a colder body will make the column of mercury descend, for the excess of radiation proceeds in this case from the thermometer, or, in other words, the rays of heat—always escaping from each distinct body—are ever (by reason of the variation as to the state of their intensity) of the same temperature as that of the substance from which they emanated. Thus the heat-ray sometimes designated the "frigorific ray," escaping from ice, only marks 32° on the thermometer, whilst that from boiling water indicates 212°. Here, of course, the interchange of the varying calorific rays produces the difference. The disparity in the degrees of the radiation of heat from bodies can easily be detected by means of the differential thermometer. For example, accordingly as a bright tin box filled with boiling water be covered with varying fabrics of different colours, so will be the amount or intensity of the caloric allowed to pass from the surface of the fluid to be registered by the above instrument. Thus, if the tin case in question be enveloped with a dark cloth, or smeared with lamp-black, it will be found to radiate heat more rapidly, or rather of greater intensity, than when covered with white cloth or colourless paint. Again, if the surface of the said box be scratched or roughened, it will be found to absorb, and also give off more readily, the rays of heat, than when bright and polished. Be it also noted that good radiators are always efficient absorbers of caloric.

195. *Propagation and conduction of heat through bodies by contact.*—If we take two substances, as a piece of metal and another of wood, of the same temperature, as indicated by the thermometer, when these are held in the warm hand the metal will feel as if colder than the wood, the heat of the hand being here more readily absorbed by the metal, it being the better conductor of caloric. Or, if we place the ends of a rod of copper and another of glass in a fire, and hold with the

hands the other extremities, the heat will be found to progress more rapidly through the metal than the glass. The propagation of heat in liquids depends very little on communication by contact; liquids are therefore heated by transposition of their parts. Thus, if with a blow-pipe, we apply heat to the bottom of a vessel containing water, in which are floating some small particles of dust, a current will be perceived of the warmed liquid rising from the point to which the heat has been applied, and another descending portion of the colder parts, which, being heated in turn, rise also; in this manner the heat is distributed through the whole liquid, for as the caloric expands the particles of water which it first meets, they become specifically lighter than the adjacent fluid, and they must therefore ascend by the laws of hydrostatics, while the heavier take their places. Little as is the conducting ability of fluids, that of gases is much less, as experienced in the use of double doors and windows to rooms. The effect of heat on gases is to increase proportionally their elasticity and this disturbing energy produces violent motions in their parts, so that the whole shortly acquires an uniform temperature. The dilitation of substances by heat is nearly proportional to the increase of temperature, except when about to change their physical or chemical states; thus, water near the freezing point expands when the temperature is diminished, which is probably owing to the different arrangements assumed by its constituent particles preparatory to crystallization.

196. *Sources of heat.*—1st, The sun; 2nd, friction. In this operation mechanical and sometimes vital energies are opposed to cohesion or adhesion, &c., and heat is called forth by reaction. When a rough body is rubbed against another substance having a smooth surface, the temperature of the former becomes greater than the latter. During the attrition of glass with a piece of cork, the first becomes the warmer in the proportion of 34 to 5 and ground glass 40 to 7. If silver be rubbed with cork, the former becomes the more heated of the two in the ratio of 50 to 12. The Indian lights his fire by the attrition of pieces of wood, and we with flint and steel or the more modern match. In North America they warm certain houses by allowing running water to cause sheets of iron to revolve on each other. Count Rumford kept water boiling by boring cannon placed in this fluid. Here the earth's natural and constant current of electricity is called into vivid operation by friction, which, acting on its associated stream of heat,

rouses it also into energetic activity or motion. Now, as electricity and caloric are, like magnetism, eternally traversing every substance in Nature, they, on entering the bodies undergoing attrition, become intensified and then evolved from the apparatus under movement. The heat thus eliminated is taken up by the adjacent media, but the electricity excited forth escapes into its surroundings by conduction. The 3rd source of heat, is chemical action, or the operation of dissimilar particles or heterogeneous substances upon each other, accompanied by a complete change of properties; 4th, origin of caloric is electrical action. 5th, source of heat appertains to animal and vegetable life; and lastly the various kinds of combustion.

197. Cold, like the word darkness, is a negative term, the one implying the absence of heat, the other the non-presence of light.

Heat changes solids into liquids and fluids into aériform vapours, and produces expansion of bulk in all bodies; it dilates solids least, liquids more, and gases most. Metals from the freezing to the boiling point of water expands thus, 350 cubic inches of lead become 351; 800 of iron expands 801; 1,000 of glass become 1,001. By the same changes of temperature the following liquids augment. Thus 1,000 parts of water range up to 1,046; oil from 1,000 to 1,080; quick-silver 1,000 portions became 1,018; and 1,000 parts of spirits of wine expand to 1,110. But every aériform body, provided it be not in contact with a liquid, expands in the same proportion, thus 1,000 parts of air became 1,373 by being heated, from the freezing to the boiling point of water.

198. *Thermometers* (from *thermos* warm and *metron* measure).—The first air thermometer was ascribed by the Dutch to Cornelius Dribble, a peasant of Alkmaur, and by the Italians to Sanetorio in 1590. Others state that Galileo was the primary inventor of this instrument. The double air thermometer was constructed in 1676, and called by Leslie the differential thermometer. The spirit thermometer was invented in 1660 by the members of the Italian Academy del Cimento. Quicksilver was afterwards used by Halley and Newton, who employed the two points of boiling and freezing water as the extremes by which to mark out the scale on this instrument. Mercury would not suit for very low, nor spirits for high temperatures, for the latter vapourises at 212°, but the former requires a heat of 600° to assume this condition.

Wedgewood's pyrometer (from *pur* fire and *metron*) was incorrect, because a low degree of heat after a time expelled the water from the clay of which it was constituted. The pyrometer invented by Mr. Daniel is the best. This instrument gives the melting point of cast-iron as 2,786°, and the highest temperature of a good blast-furnace about 3,300°, whilst Mr. Wedgewood's apparatus gave 20,570° and 32,277°.

199. *Expansion and Contraction.*—This latter property or ability appertaining to metals is found to be enormous, as exemplified by the wheelwright in putting on the tire of his wheel, the cooper the iron hoop that is to encircle his cask. Again, the plates for boilers of steam engines are joined together with incandescent rivets, which on cooling effectually closes them. Expansion has taught engineers to provide for the above contingencies, when employing iron pipes, that may become exposed to varying heats, by allowing the one to slide within the other. Southwark-bridge is known to rise one inch during a warm day; the circumstances of expansion and contraction should be attended to when constructing buildings made of iron, and also by the blacksmith on shoeing a horse. It may be here mentioned that water expands above and below 40° and also when freezing.

200. *Further concerning the Conduction of Heat* (see sec. 195).—The most dense bodies are generally the best conductors of caloric, and of these, metals are the most efficient—thus, gold represents a conducting ability of 1,000, marble 23, porcelain 12, fine clay 11. Gems are better conductors than glass. As regards metallic substances, some convey heat more readily than others, thus, gold represents 1,000, silver 973, copper 898, platinum 381, iron 374, zinc 363, tin 303, lead 179. Fluids are very bad conductors of heat, and it has never been proved that gases convey caloric at all. Metals at 120° will burn the hand, but it will be found that we can tolerate water at 150° if the hand is kept still, and air at 300°. Sir J. Banks sat in a room at 260°. On the contrary, if the air is still, we can support a temperature of 55° below freezing mercury. Vapours are very bad conductors of caloric, as seen where water rests on the steam which separates it from the hot iron plate.

201. *Convection of Heat* (from *con* with and *veho* to carry) *the ability in fluids of transmitting heat or electricity by currents.*—Equilibrium of temperature is effected in liquids by circulation, or rapid change in the relative position of adjacent particles, this process has been appropriately termed *convection*,

and is employed to warm rooms with water or hot air. Conduction of caloric in some degree causes the winds and likewise the land and sea breezes. It also effects freezing and thawing of water.

202. *Heat of Composition.*—A pint of water at the temperature of 100° and another at 50° give, when mixed, the mean of 75°; if, however, the same measure of quicksilver at 100° be added to another of water at 40°, the resulting temperature of the two will not be 70°, or the mean, but ten lower, or 60°, so that the mercury will lose 40°, whereas the water only gains 20°, yet the latter must contain the whole caloric which the quicksilver has lost; hence it appears that water has a greater capacity for heat than fluid mercury. In addition, if a measure of water at 100° be mixed with one of quicksilver at 40°, the resulting temperature will be 80° the water thus falling 20° degrees, but in this descent it will give out sufficient heat to raise the mercury 40°. Again, the specific capacity of oil for caloric is only half that of water. Dr. Black, in 1757, discovered that a pound of water at 32° and another at 212° produce a mixture of 122°, but equal weights of ice and water, the latter being heated up to 212°, only produced a temperature of 52°, the water losing 160° whilst the ice only gained 20°, therefore 140° were expended in changing ice into water; thus this fluid, on becoming ice, must lose an equal proportion of caloric, showing that water is composed of ice and heat. It is worthy of remark that those bodies which are most readily heated are as quickly cooled, as with quicksilver and water.

203. *Condensation as a Source of Heat.*—This may be witnessed when mixing spirits of wine or sulphuric acid with water, also by suddenly compressing air, or after hammering iron or lead. As a general rule, heat is the sequent of compression and the opposite is the result relative to expansion. The liquefaction of all bodies requires a vast quantity of caloric, which in a degree becomes hidden, yet when water is poured on quicklime this fluid becomes solid, and great heat is evolved.

204. When certain fluids evaporate cold is the result, this sequence enables us to freeze them in an exhausted receiver, or with Dr. Woolastan's cryophorus (from *cruas* ice and *phero* —I bear), by means of this instrument water freezes in consequence of its own evaporation.

(*a.*) It is found that water under a pressure of 50 atmospheres marks 510° by the thermometer.

(*b*.) In the formation of steam there are 900° of heat rendered latent, which is made evident by passing one gallon of water under the form of steam into 5½ gallons of this fluid; at 32° the latter will become heated up to the boiling point or 212°.

(*c*.) When water is converted into steam, it undergoes a much greater expansion of volume, than any other liquid, thus, one cubic foot of water forms 1,689 square feet of vapour, alcohol 493, ether 212, turpentine 192.

(*d*.) Steam under very high heat and pressure does not—when escaping—scald the hand if held in it. This result ensues from the sudden expansion of the vapour, which dilatation absorbs heat, but the chief cause of this sequence is its sudden and forcible mixture with the cold atmosphere at its first rush, for a large quantity of air is thus violently drawn along with it in its course.

(*e*.) It has been proved that liquids evaporate at all temperatures, even quicksilver from 60° and upwards, as proved by Faraday. Thus, he placed some mercury in the bottom of a glass phial, to the stopper of which he attached a piece of gold leaf. This speedily became white, from the amalgamation of the gold with the vapour which rose from the metal.

(*f*.) When a vessel of water is placed upon the fire, its temperature gradually rises to 212° then, although it remains upon the burning fuel it does not become any hotter, but is gradually converted into steam or vapour; so that the effect of the heat is not to elevate temperature, but to change state or form. Hence steam, though not more heated, as far as regards the thermometer, than boiling water, from which it emanated, contains a much larger quantity of caloric, and this heat again makes its appearance, when the steam is condensed or reconverted into water. At whatever temperature vapour is produced, it is similarly constituted; and that which escapes from water in its ordinary state, by the process usually called *spontaneous evaporation*, resembles the former in all respects; hence it is, that vapourization is to surrounding bodies a cooling process, and that in the converse change, or the return of the vapour to the liquid state, heat is evolved and rendered sensible. Further, the ultimate processes of evaporation and condensation tend to that distribution of heat over the great earth which serves to preserve the well-being of the organic creation. Heat is thus carried in its hidden condition to the colder upper regions of the air, and is there given out in its free state by the

condensation of the vapour, and upon this silent and never interrupted process, mostly depend upon the fluctuations of the aerial ocean, which tend so greatly to its salubrity, and which produce the variations in the barometer.

205. *Further Touching Vapourization.* — Gay Lussac discovered that liquids are converted more readily into vapour when in contact with angular and uneven surfaces, than when the superficies of the things they touched were smooth or polished. He also noticed that water boils at a temperature two degrees higher in glass than in metal utensils. This economy ensues from the more ready escape of the *ever-flowing* electricity from bodies which terminate in granular points or spikes. This ever motive fluid always regulates the motion of heat when undulating, as it constantly does, out of one body into that of another.

206. *Radient Heat.*—The experiments of Melloni have rendered highly improbable that *differences exists between certain rays of heat, which are no doubt analogous to the variations appertaining to colour.* Although the rays of heat cannot, like distinct hues, at present be made evident to the sight (though they are to the feelings of clairvoyants) they may be established by particular physical properties and relations, just as different natural qualities may be found, independent of their colour, in the distinct rays of luminous spectra or screen images. Radient heat, like light, can pass through some few substances, but is arrested by the greater number, and also subject to reflection, absorption, secondary radiation, and polarization. Many bodies, as before observed, radiate caloric and electricity, according to their roughness and colour. Thus, a radiating surface covered with glue was equal to 80°, whilst that of clear metal was only 12°. Assuming lamp-black as radiating 100, sealing wax will be 75, writing paper 98, crown-glass 90, China-ink 88, red lead 80, plumbago (black lead) 75, tarnished lead 45, clean lead 17, polished iron 15, tin, gold, silver and copper 12.

207. Leslie found that the direction of the lines by which a surface was roughened had a considerable effect upon the radiating result. Thus, he scratched a bright metallic face with a number of lines in one direction, and found the ability of radiation increased; he then marked a similar surface with the same number of lines, half of which crossed the other at right angles, and obtained a still greater effect. The energy of the projection of heat seemed here again to depend upon the num-

ber of points or angles produced, like the escape of electricity from pointed bodies. Melloni ascertained by experiment that the differences of radiation in metallic bodies do not arise so much from the disparity in the state of their faces as from changes in their densities. Thus he formed two vessels of pure silver, one of well-hammered plate, and the other of cast metal slowly cooled. He then polished one side of each very highly, and the other he scratched with emery-paper in one direction only, and filling them both with hot water, he found that in the case of the polished surfaces the last radiated nearly one-third more than the forged metal, showing the superiority of the lesser density. 2ndly. He discovered that in the case of the scratched superficies, that not only did the hammered metal show an augmentation of radiating ability of four-fifths, but in the last metal there was a diminution of nearly one-fifth; the latter unexpected effect arises, according to Melloni, from the compression of the soft surface of the cast metal by the action of the hard emery.

208. That bodies are continually emitting rays of heat is evidenced by their growing cold at night, and again by covering the bulb of a thermometer with some good radiating surface, as the short white fibres of wool or cotton, then placing it in the focus of a concave metallic mirror, and turning the apparatus towards the clear sky, the thermometer will fall several degrees. Again, the formation of dew, shows that substances radiate caloric by their becoming cold after sunset. Further, pieces of ice radiate heat—falsely called *cold* rays—which can be detected in the focus of a mirror (see sec. 194). Sir H. Davy found that bodies radiate three times as much in vacuo, as they do in the common atmosphere, as exemplified with ignited charcoal placed in the air-pump. This fact points out that caloric is one of the imponderable material elements of gravitating matter.

209. When hydrogen and oxygen are burning together there is little light, but intense heat, and if a convex lens be held before it, the radient heat which will pass through it will scarcely affect a delicate air-thermometer; but if a piece of solid matter, capable of resisting its action, such as a wire of platinum, be held in it, radiation will immediately take place. A piece of lime thus presented to the flame undergoes no chemical change, but emits a light like the sun, and radient heat is at the same time projected of sufficient intensity to penetrate the lens, and to inflame phosphorus situated in its focus.

(a.) Colours hold an influence over radiation which effective sway decreases in the following order: black, blue, green, purple, red, yellow, white.

210. *Polarization of Heat.*—This capability of radient caloric was first discovered by M. Berard; it may be best produced with plates of mica (from *mico*, I shine). This elastic mineral occurs in lamina of different colours in granite. Professor Forbes has shown that heat is polarized both by reflection and refraction. He succeeded in depolarizing caloric, and thereby proved that heat possesses the property of double refraction.

211. *Expansion of Bodies by Heat.*—If we heat 1,000 cubic inches of air from the freezing to the boiling point of water, it will sustain an increase in bulk of 375 parts, water 45, iron 4.

(a.) In regard to Unequal Expansion of Solid Substances at Different Temperatures.—Each portion of heat that enters a body must weaken its cohesion, and therefore renders the operation of the next portion that is introduced more efficacious.

(b.) Unequal expansion of surfaces cracks our thick glasses and plates. We sometimes avail ourselves of this expansive effect of heat upon glass, in cutting off parts of vessels by causing a crack to follow the direction of a red-hot wire traced upon the surface, common watch-glasses are in this way cut out of a glass globe. The backs of grates and the dampers of flues are frequently broken in this way; they are less liable to these accidents when slightly curved.

(*c.*) The expansion of glass and platinum is nearly equal, hence wires of that metal may be welded into fused glass without inconvenience, but not so with other metals. Iron and steel are less expansile than brass, thus they warp when joined together, one way on applying heat, and the contrary on being cooled. Silver and platinum are remarkably susceptible of these contortions, and such contrivances have been applied to the construction of instruments for measuring changes of temperature, as in Breguet's thermometer, which consists of a very thin and narrow strip of platinum plated with silver and coiled into a spiral, one end of which is attached to an upright support, and the other to an index moving over a graduated circle. The expansion and contraction of metals interfere with clocks and watches. The pendulum, to vibrate seconds, must always be of a given length, and should be made of iron joined to brass.

(*d*). Two parts bismuth, one lead and one tin, forms an alloy

which at 32° expands until it attains 111° ; it then contracts up to 156°, when it has attained its maximum density, occupying less space than at 32° ; it then again progressively expands, its point of fusion being 201° ; during cooling it attains it maximum volume 111°.

212. *Expansion of Liquids.*—This quality is perceived when coloured spirits of wine is introduced into a vessel with a glass ball and long stem, as with certain thermometers. Liquid carbonic acid is more expansile by caloric than air : when heated from 32° to 86°, twenty volumes of this liquid increases to 29, which dilitation is four times greater than that of air.

213. *The Expansion of Gases.*—This capability, though great in amount, the energy developed is small as compared with that of solids and liquids under the same circumstances, in consequence of their extreme elasticity. Rudberg found carbonic acid, protoxide of nitrogen, and cyanogen, present under the same circumstances a higher degree of expansion than other gases.

214. When heated copper bars of an oval shape rest on cold lead, vibrations are set up in the bars that resemble the sonorous pulsations of tuning forks or the Æolian harp. This fact reminds us of the Memnonian statue, which gave out sounds when heated by the sun's rays.

215. The above reported phenomenon is not fabulous, for Humboldt speaks of certain sonorous vibrations being heard to proceed from certain rocks on the banks of the Oronoko at sunrise, which he erroneously attributes to the confined air making its escape from the crevices opening into the caverns, where the difference of the internal and external temperature is considerable. The French *savans* certify to having heard such sounds at Carnak, on the east bank of the Nile. (See article Sound.)

216. *Further as regards the Conduction of Heat.*—Different materials of clothing vary in their conducting ability. In Count Rumford's experiments relative to this subject, the air was not taken into account : yet it is now known that the closer or harder we pack cotton, silk, and eiderdown, &c., the more rapid will be the escape of heat from them, hence the apparent warmth of quilted apparel, by reason of the interstitial air being a bad conductor of caloric. Pure flame, as those of burning spirits, are bad conductors of heat, so also are clean grains of gunpowder, hence when dropping them into the flame of a spirit-lamp they do not take fire; on the contrary,

iron filings instantly burn, forming an oxide of the metal. In addition, heated substances are cooled by creating currents over them as by radiation. Lyell mentions a glacier near the summit of Mount Etna that remained unmelted in consequence of its having been covered by volcanic dust, over which a current of lava afterwards flowed. Paper does not singe rolled on metals, because they are good conductors of heat, but the same material rapidly scorches when forming a covering to wood.

217. *Capacity of Bodies for Heat.*—Dulong and Petit in their experiments showed—as Dalton had previously anticipated—that the specific or peculiar heat of substances increases with their temperatures, so that it requires more caloric to raise them to a given number of degrees when they are at a high than at a low temperature. When the density of a body is diminished, its capacity for heat is increased, and *vice-versâ*, as seen in hammering metals, passing bars of iron through rolling mills, and stretching a piece of indiarubber. Liquids and gases when compressed give out caloric, and *vice-versâ*, as seen, relative to the latter, on opening the stopcock of an air-gun. Some solids rise in vapour before fusion, and in order to liquify them they require to be heated under pressure.

It requires twenty-one times as much heat to bring ice into the state of water and to elevate it up to 40°, as to raise ice-cold water to the same point. The difference between the gain of temperature in the ice and the water, with equal accessions of caloric, is 140°, and thus 140° is the expression of that quantity of thermometric heat or temperature which disappears, or is rendered latent, by the separate operation of the liquefaction of ice; the actual quantities of matter in the comparison being the same. If we take snow at 32° and mix it with an equal weight of water at 172°, the snow melts and the mixture becomes 32°, the water losing 140°, while the temperature of the snow remains as at the outset of the experiment. (The fact is, that ice and snow consists of a certain quantity of oxygen, hydrogen, and heat, &c., whilst water is compounded of oxygen, hydrogen, and a *greater portion* of heat, &c.) Again, red-hot lead is instantly cooled down to the point of its fusion (612°) by the addition of a piece of solid lead.

218. *Relative to the Congelation of Water.*—The thermometer remains stationary at 32° till the whole of the water is frozen,

after which the temperature of the ice begins to sink. Water, while congealing, is constantly imparting caloric to the surrounding atmosphere, for a delicate thermometer suspended above it is constantly affected by an ascending stream of air less cold than the atmosphere around. The inducement of a lower temperature by the liquefaction of metals, is shown by melting together 207 parts of lead, 118 of tin, and 284 of bismuth, these form on cooling a brittle alloy, which, when reduced to powder and dissolved in 117 portions of mercury at 60° produces a liquid amalgam which falls to 14°. Five parts of sal ammoniac, 5 of nitre, and 16 of water, reduces the fluid from 50° to 10°. There are many other freezing mixtures. (*See a list in Brand, page* 69.) A solution of Glaber's salt when suddenly crystalized gives out heat, which is referable to a part of the water becoming solidified, as is the case with water—as before noticed—when thrown on lime.

219. *The Caloric of Fluidity or Latent Heat.*—This spiritous material principle enters into the composition of bodies in certain proportions; thus water contains 140°, sulphur 144°, spermaceti 145°, lead 162°, wax 175°, zinc 495°, tin 500°, bismuth 550°.

220. *Further concerning Vapourization.*—A cubic foot of water forms 1,689 of steam at 212, alcohol 493, turpentine 192. For practical purposes a cubic inch of water may be said to form a cubic foot of steam, which is lighter than air, being as 625 to 1,000. The vapour of alcohol, turpentine, and ether is heavier than the atmosphere. Fogs and clouds is vapour in vesicles; if the former consisted of drops, however small, they would fall to the earth through gravity. Saussure saw the above vesicles on the Alps as large as peas. It has been noticed that the nature of the vessel often influences the boiling or vapourizing point of water, thus in a glass flask it is high and irregular, but upon throwing in a few metallic filings, &c., the boiling point falls to its standard. Water boils on Mont Blanc at 187°, and the sea level at 212°. This fluid can be made to re-boil by pouring cold water on a flask with a stopcock in which ebullition has just ceased, from condensing its contained vapour, but the boiling again ceases on holding the flask near the fire. The temperature of steam is the same generally as that of the liquid producing it, hence the high heat of steam generated under pressure.

221. *Temperature* is merely a relative term, for we may suppose ourselves in a heated medium so high, that red-hot iron

would radiate cold rays; or again, in a temperature so low, that ice would eject rays of heat.

(a.) Lowing has succeeded in solidifying spirits of wine at 144° below zero.

(b.) Different kinds of Caloric.—From Melloni's experiments he suggested that as there are varieties of light characterized by being mixed with varied colours, so there are different kinds of radient heat, *dependent* upon the sources whence it emanates. *(c.)* Rays of light which have passed through blue glass will be transmitted more readily through a second blue vitrious substance than through one of a different colour, and calorific rays which have permeated water will pass more readily through a second stratum of this fluid than through other liquids, otherwise more diathermanous. Hence it follows that comparatively little additional heat is absorbed either by increasing the number or thickness of screens of the same material. *(d.)* All heated bodies placed in an enclosed space assume in time the temperature of the enclosure.

222. *Additional Facts as regards Expansion.*—It has been proved that zinc is the most expansile of metals; it dilates nearly four times more than platinum from the same heat; but ice, of which the contraction by cold as been observed from 30° to 40° under the freezing point, prove to be more dilatible even than the metals; the rate of expansion of this solid being in the proportion of 1-267th, while the zinc is 1-323rd part, only. Professor Mitocherlich has discovered that the angles of some crystals are affected by changes of temperature. This proves that some solids in the crystalline form do not expand uniformly, but more in one direction than another, and while one crystal is dilating in length by heat, it may be actually contracting at the same time in another dimension. The same kind of glass dilates more when in the form of a solid rod than in that of a tube. Solids expand at an accelerated rate, particularly when heated up to near their fusing points. Liquids are progressively more expansile at higher than at lower temperatures.

223. Graham states that bodies at different temperatures emit *different species of rays of heat,* which may be sifted or separated from each other by passing them through certain transparent media. They may be all emitted simultaneously, and in different proportions, by flame; but heat from sources of lower intensity, some of them are always absent. The calorific rays from the sun are chiefly of the kind which pass through glass;

but Melloni shows that the other species are not altogether wanting. The rays of heat emitted from the orb of day, and other luminous bodies, are quite different from those of the light with which they are accompanied. Prevost, of Geneva, has proved that bodies radiate caloric at all times and temperatures ; it is owing to this economy that dew is formed—from the cooling of the earth by radiation. Heat, in its passage through a bar of iron, is probably radiated from particle to particle. Dr. Black taught that metals owe their malleability and ductility to a quantity of interstitial latent caloric, or rather heat of composition combined with them. When hammered they become hot from the disengagement of this caloric, and at the same time *brittle*, showing a change in their constituents. The malleability of these bodies is restored by re-heating them in a furnace. The diamorphism, or that property to assume two different crystalline forms, may likewise depend upon the retention of a certain quantity of caloric of composition by the body in the one form, and not in the other. Thus sulphur assumes two features, one on cooling from a state of fusion by heat, another in crystallizing at a lower temperature, and probably with the retention of less constituent heat of composition when formed from a solution of sulphuret of carbon.

224. *Materiality of Caloric.*—Everything relating to the absorption of heat suggests the idea of its substantial or imponderable material existence, for caloric, unlike one of the characteristics of light, is never extinguished when it falls upon a body, but is either reflected and may be further traced, or is absorbed and accumulated in the substance it impinges upon, and may again be derived from that substance without loss. But the mechanical phenomena of heat, which resemble those of light, may be explained with equal if not greater advantage by assuming that it has an undulatory character, corresponding to that of light. Heat, like the spirituous matter of sound, can be brought to a focus in a pair of conjugate mirrors. In adopting the material property of caloric we are under the necessity of assuming that there are different kinds of heat, some of which are capable of passing through glass, such as the heat of the sun, while others, like that radiating from the hand, are, from want of intensity, entirely intercepted by glass. But, on the undulatory law, the dissimilar properties of caloric are referred to differences in the size, or rather physical energy, of the waves as the variations of colour are accounted for when mixed up or incorporated with light. Heat of the

higher degrees of intensity, however, admit of a kind of degradation or conversion into caloric of a lower energy, to which we have nothing apparently parallel in the case of the material principal of light. Thus, when the calorific rays brought into action by the sun, which are of the highest *intensity*, pass through glass and strike a black wall, they are absorbed, and appear immediately afterwards radiating from the heated wall, as rays of a low intensity or less energy which are no longer capable of passing through glass. It is as yet an unsolved problem to reverse the order of this change, and convert heat of a low ability into caloric of a high intensity. The same degradation of heat or loss of energy is observed in condensing steam in the process of distillation. The whole heat of the steam, both latent and sensible, is transferred, without loss in that operation, to perhaps fifteen times as much condensing water, but the intensity of the heat is rendered from 212° to perhaps 100°. The caloric is not lost, for the fifteen parts of water at 100° are capable of melting as much ice as the original steam. But by no quantity of this heat at 100° can the temperature be raised above that degree; no means are known of giving it intensity.

225. *Heat Rendered Energetic by Pressure.*—If heat of low tone is ever changed into caloric of high intensity, it is in the compression of gaseous bodies by mechanical means. Let steam of half the tension of the atmosphere, produced at 180°, in a space otherwise vacuous, be rendered into half its volume, by doubling the pressure upon it, its temperature will rise to 212°. If the compression be again doubled, the temperature will become 250°, and the whole heat or caloric of composition of the steam will now possess that high intensity. When air itself is rapidly compressed in a syringe, a remarkable conversion of caloric of low into heat of very high intensity is the result, or, in other words, the heat before compression was diffused through a larger space, and by condensation the diluted caloric, so to speak, became concentrated, and, of course, more effective or energetic.

226. *Further concerning Heat, the Result of Friction.*—It may be imagined that the elevation of temperature produced by the friction of hard bodies upon each other has a similar origin to the foregoing, and that the results from the conversion of heat of low intensity, which the bodies rubbed together possess, into heat of a high energy. But it would be necessary again to suppose that a supply of caloric of low intensity

to the bodies rubbed can be endlessly kept up, by conduction or radiation from contiguous bodies, as there is certainly no limit to the production of heat by means of friction, as experienced in Count Rumford's experiments. Davy succeeded in melting two pieces of ice in the vacuum of an air-pump, by making them rub against each other, while the temperature of the air-pump itself and the surrounding atmosphere was below 32°. Mr. Haldot observed that when the surface of the rubber was rough, only half as much heat appeared as when the rubber was smooth. When the pressure of the rubber was quadrupled, the proportion of caloric evolved was sevenfold. When the rubbing apparatus was surrounded by bad conductors of heat, or by non-conductors of electricity, the quantity of heat evolved was diminished. According to Pictet, a piece of brass rubbed with a fragment of cedar-wood produced more heat than when rubbed with another piece of metal, by reason of their good conductibility. The elimination of heat was still greater when two pieces of wood were rubbed together. He also found that solids alone produce heat by attrition upon each other. No caloric seems to arise from the friction of one liquid upon another, or a fluid upon a solid, nor the friction of a current of air or gas upon a liquid or solid.

227. *Repulsion of Bodies by Heat.*—A repulsive ability in heated bodies is inferred to exist from the appearance of extreme mobility which many fine powders assume, such as precipitated silica, on being heated nearly to redness. Professor Forbes also attributes to such a repulsion the vibrations which take place between metals unequally heated, and likewise the production of tones. But this repulsive sway was rendered conspicuous, and even measurable, by Dr. Powel, in the case of glass leaves, of very slight convexity, pressed together. On the application of heat, a separation of the glasses, though extremely small, but finite spaces, was indicated by a change in the tints which appeared between the lenses and which depended for their development upon the thickness of the included portions of air. This repulsion between heated surfaces appears to be promoted by whatever tends to the more rapid communication of heat.

228. *Formation of Dew.*—Wool placed upon a metal will acquire much less dew than an equal quantity laid upon grass in the immediate vicinity, and conversely, bodies on which the metals are deposited have an influence on the quantity of

dew which the latter will attract. The metals do not all resist the formation of dew with the same ability. Thus Dr. Wells one night saw platinum distinctly dewed, while gold, silver, copper, and tin, though similarly situated, were entirely dry, and he several times perceived these four metals free from dew, whilst iron, steel, zinc, and lead were covered with it. Wool and swan's-down is from 10° to 15° of lower temperature than the air at night. When the sky is cloudy the grass is often 12° higher than the air. In a fine morning the thermometer is often 55° in the air, whilst the grass is 38°, sunflower 36°, cabbage 34°, hoary geranium 30°, and covered with hoar frost; thus the upper strata of air adjacent to the earth will be warmer than the lower. Fogs increase in the valley because the atmosphere is more tranquil. Grass and low shrubs are covered with dew more than trees; substances which are good conductors of electricity, do not collect the dew, but non-conductors do, and are covered with ice on a frosty morning, as is glass, and wool, &c. Bodies that become cold through radiation condenses the warmer damp air surrounding them, and thus is squeezed out its contained moisture, like water is derived from a moist sponge when compressed. It is supposed by people in general that the dew falls from the air or rises out of the earth; had either of these processes obtained, all things would have been covered equally with moisture, which is not the case; each separate object becomes bedewed according to its radiating ability or capacity of becoming cool.

229. *Meteorology.*—Heat increases the elastic ability of air, and hence the equilibrium of a mass of the atmosphere unequally heated is constantly disturbed. The currents of warm and cold air change places, the cold atmosphere moving to the warmer region, and thence, when heated, repeating the course of the previous warm air. The unequal distribution of caloric in the atmosphere is a main source of the velocities and direction of winds, and consequently of the distribution of climate; but on the other hand, the earth itself having its own apportionment of heat, reacts on the atmosphere and produces dew. In like manner the sea and the polar fields of ice materially affect the general distribution of caloric. With respect to the heat of the external stratum of the earth, it is principally dependent on the radiation, or rather the exciting influence of the sun on the local heat, the intensity of the effect of which is contingent on the duration, also on the obliquity of the solar rays, both of which are dependent on the declination of the sun and the

latitude of the place. The integral or total taken throughout the year rests therefore solely on the latitudes; from this integral the calculated mean temperature is derived, but differs in most cases from the observed, inasmuch as the propagation of heat in the sea and air affects equally those places in the same parallel which are near to or distant from the coasts, and the unequal quantity of continent in the northern and southern hemispheres produces a similiar result to them. By clearing a country of woods and marshes we increase its temperature. The heat on any point on the surface of the earth varies from hour to hour with the rotation of the globular mass on its axis, day by day and from season to season, with its revolution round the sun, and from year to year with any change in the dimensions or form of the earth's orbit.

230. The thermometer rises one degree for every 15 yards we descend from the level of the sea towards the centre of the earth.

231. The earth, if it was not for the antagonistic ability of heat, electricity and magnetism, &c., might be compressed into the space of a common room, and its density be unimaginable.

232. If a cubic inch of water in the form of steam at a temperature of 212° be introduced in the same vessel with 5½ cubic inches of water at the temperature of 32°, the steam will be immediately converted into water, and the ice cold fluid will be raised to 212°, and there will be found in the vessel 6½ cubic inches of water at 212°. Thus while the steam, in resuming the liquid form, has lost none of its temperature, it has nevertheless given up as much heat as has raised 5½ cubic inches of the water from 32° to 212°. It is therefore demonstrated that this quantity of caloric was actually in the steam, and it was its presence there, in the latent or compositional state, accompanied with electricity, &c., that conferred upon the water—in the form of steam—the property of elasticity; this quality of elasticity is the result of condensed caloric, &c., which can react upon depressed bodies, like a spring on the compressed atmosphere in an air gun. Steam cannot be condensed into water, you by this process only raise its temperature; to convert it into fluid it must be cooled, but here only a portion of the steam, adequate to the cold, is condensed, since you cannot cool steam below 212° without converting it into water or its vapour.

233. The surface of the solid body of the sun is, no doubt, as temperate as that of the globe we inhabit, and it may be peopled

with a race of giants, whose muscular ability may enable them to overcome its great attractive influence. The generation of the *sensible* heat of the sun's atmosphere and the aerial element of the earth, must be from electrical and magnetic excitement.

a. If light and caloric, &c., emanated from the sun and stars, they must collect or be deposited somewhere, and the solar and astral bodies would hourly grow less influential, and the planets exposed to the dominance or deposition of these imponderable material elements, must in time become endowed with a temperature that would preclude the existence of animal and vegetable life, and also crystalline form.

b. If we could be transported to a distant locality above the earth's atmosphere we must cease to live, and also become rigidly torpid, from being exposed to unimaginable cold from the absence of any heat rays. This circumstance would prove that light and caloric, &c., are alone resident in the atmospheres which envelope the solar and planetary systems.

c. Our nearer approach to the sun produces no sensible difference relative to warmth, as recognized during the early spring and fall, when we are millions of miles nearer the orb of day than at the midsummer solstice.

d. All that we know as regards the production of heat tends to show, that by no process which can take place in or upon this earth or elsewhere can it be created; it has ever had and will continue to have a perpetual subsistence.

e. The process of combustion, percussion, friction, and chemical action, merely evolve the caloric that was, previously to these operations, latent or hidden, and originally formed part of the bodies acted upon. Further, the caloric of composition must have been *originally* derived from other sources, since heat, light and electricity have had an eternal persistence, being unalterable save in character, quantity, and intensity.

234. To the influence of heat is chiefly due the endless variety of the forms and developments that spread over and beautify the surface of the globe we inhabit. Neither the dry land nor the waters of the earth, or the air which enwraps it, could exist as they now are, in the absence of caloric. Without heat the atmosphere we breathe would harden into a crust, which would envelope the world and entomb all that belongs to it. Heat is the parent and the nurse of the endless varieties of organization. The vegetable and animal kingdoms and even the mineral world are its offsprings. Every imaginable object

that can affect our senses is produced through its agency, and is maintained by its influence. Withdraw heat from our surroundings, and instantly all motion and even form and consequently everything that beautifies life, would cease to have a being, and shapeless, stagnant chaos would everywhere prevail. All gases must become solidified by the abstraction of their caloric, and hydrogen, the lightest among them, would no doubt become a metal. The Greeks were right when they propounded that fire was the external and visible form of heat; they regarded caloric as the cause of vitality and the disposer of every organized or unorganized condition of matter. Dr. Hope observes, that heat is a long chain—both ends out of sight—of which we can appreciate but a few links.

235. *Influence of the Sunbeam.*—The invisible rays (which are those of heat) and not the sun's perceptible undulations (which are pencils of light) produce the calorific ability and accomplish the melting of the mountain snows and the evaporation of the seas and inland waters. These fluids absorb and filter away the dark rays or those of heat, from the beams of light, as exemplified by Professor Tyndal, when he passed the rays from the electric lamp through a narrow glass trough filled with water, and then brought them to an intensely brilliant focus. The rays thus filtered still contained sufficient heat to set fire to brown paper, but hoar frost was not touched by them, because being transparent or pervious to these rays it let many of them pass through without absorption. The Professor first set fire to brown paper in the focus and then placed a flask covered with hoar frost in the same focus, but the snow remained unmelted. Then he stopped all the visible rays (or those of light) by the interposition of a glass trough filled with a solution of iodine in bisulphate of carbon, a solution which is transparent to the invisible rays (or those of heat). He next removed the trough of water. This allowed the invisible rays to pass on to the focus, whilst the visible rays (or those of light) were cut off by the solution of iodine. When the flask coated with hoar frost was placed in the dark focus, the heat (thus concentrated and intensified) at once melted it from the surface, wherever the glass was brought into the centre of action.

a. The above experiments prove that the sunbeam, whose constituents exist in the air we breathe, is made up of at least two distinct elements; the one consisting of rays of heat, the other of luminous beams. On projecting these imponderable

principles through the dark solution, it intercepted the element of light, and thus *concentrated* and of course *intensified* the heat rays, by which process they were rendered capable of melting the hoar frost. It should be taken into consideration, as regards the brown paper and snow, that the former is very inflammable and the latter not at all. Further, the crystals of ice contain ten times less heat of composition than the paper, hence this tissue can be readily excited into igneous action, and the more readily from being imbued with very ignitible bituminous materials. In continuation, Professor Tyndal now proceeded to explain the process of expansion of the atmospheric currents in the tropics, and the origin of the overwhelming torrents which follow when the heated air is afterwards chilled and condensed, and how these currents flow in the upper regions from the Equator towards the Poles. Thus, the village of Cachirciveen, in Ireland, is often deluged by showers of rain, because the mountains behind it so frequently condense the warm winds from the Atlantic, which are charged with vapour. The nature of clouds, observes the Professor, may be compared to the white mist issuing from the spout of a kettle. Steam or water-gas is perfectly invisible, and it is only when the vapour is precipitated by cooling into a multitude of minute drops of water which float in the air that the cloud is produced, which is often erroneously called steam. The vapour which issues from the chimney of a railway engine is invisible at the mouth of the funnel, but a few inches higher up it is cooled into a cloud. By raising the temperature of a cloud it can be re-converted into steam or vapour.

236. *Burning Glasses.*—Buffon melted small steel bars in five minutes, and set fire to wood 200 feet distant, and tin was fused at 150 and lead at 140 feet from the apparatus. The ability of the action of burning glasses become lessened as we ascend in the atmosphere, as noticed when using them on very high mountains, as the Himalayas in the north of India, which are some of them upwards of five miles in altitude.

237. By allowing a small jet of steam to pass into our fires we should prevent smoke, by causing it to be consumed, increase the heat, and save 33 per cent of coal. The blacksmith exemplifies this fact by vapourising the water he applies to his forge fire.

238. *Contraction of Metals.*—Mercury, unlike water, in freezing, contracts enormously. It is found that most metals undergo sudden condensation whilst progressing from the fluid

to the solid state, except cast iron, bismuth, and antimony, all of which expand. A metal which contracts when passing from the liquid to the solid state cannot be made to take the shape of a mould, hence our coinage is stamped. Metals that dilate on cooling take impressions with great precision.

239. The eggs of certain animals are hatched at almost any temperature; thus some are fruitful from 104°, 45°, and even down to 13° F. The cold that kills animals does not affect their eggs. Light, unlike caloric, acts unfavourably in the hatching of ova. The heat that may kill one plant or animal will be necessary to the economy of another, as seen among the plants of the poles and tropics. In the hot springs near a river in Louisiana, *conferuæ* (river weeds) grow at 122° and 145° F.

240. *Repulsion.*—Heat maintains such a repellent energy, that fluids cannot touch a highly heated body, If the volatile substance iodine be put into a glowing hot capsule, it resolves itself immediately into a spheroid. Potash readily combines with iodine, but if a piece of this alkali is thrown upon the iodine situated in the capsule, it also takes the globular form, and both bodies revolve independently of each other, their chemical affinities being entirely suspended; but allow the capsule to cool, and they then combine immediately. Heat here gives rise, in one sense, to motion that overcomes chemical action, and prevents the usual development of its ability. Like electricity, it subjugates the quality of gravitation. This last property of ponderable matter is also checked or destroyed when two bodies in motion violently strike each other, and recoil after contact. Be it observed that this rebounding takes place at the moment when the two bodies in question, by approximation, ought to be at the acme of their attractive ability; this repulsive achievement is the result of an electro-magnetic re-action (see article on *Motion*). When sulphurous acid is put into a red hot platinum crucible, it is repelled by the incandescent pot, and gathers into a spheroid. On adding water to this acid it brings it into contact with the heated vessel, and then the acid instantly flashes off, and the water becomes a lump of solid ice.

241. *Addenda* (a) *Vaporous Expansion.*—Roger Bacon, born in Somersetshire in 1214, first described the application of steam ability. The French ascribe the practical use of the principles of vaporous expansion to Solomon de Caus, of Frankfort, in 1615.

Steam Engine.—To Hero, of Alexandria, 284 B.C., is attributed the æolopile, which, although a toy, possesses the properties of the steam engine. The first locomotive engine was invented by Murdoch, 1784. He was a native of Redruth, in Cornwall, and Trevethick, also of Cornwall, was the first that worked a locomotive on a railway, which was effected at Merther Tydvil in Wales, 1804, and this paved the way for the subsequent success of Timothy Hartworth and George Stevenson.

Steam Navigation.—Blasco de Garay, a Spanish captain, in 1543 had made and afterwards exercised a *steam vessel* in the port of Barcelona, but afterwards laid it aside owing to the bigotry of a certain imperial officer. Patrick Miller and W. Symington, in 1787, are reported to have constructed a steam boat that travelled four miles an hour. Symington, 1790, made a passage on the Forth and Clyde canal. Fulton's steam boat, *Clermont*, was exhibited on the Seine, August 9th, 1803; he also started a steam vessel on the river Hudson, America, in 1807.

b. It has been found that the presence of air in the water of the boiler prevents the steam from exploding.

c. Salt water has no maximum of density so long as it remains fluid, and even when ice begins to form in it, the residual fluid-part always increases in density in proportion to the degree of refrigeration.

d. Nine cubic inches of water become ten by freezing.

e. In France, the engineers found that on boring 1700 feet, they obtained water of 100° F.

f. Encke's comet contracts when approaching the sun, and dilates as it leaves this luminary. This fact proves that heat does not emanate from the sun.

g. Air in expanding in vacuo, does not consume heat—in fact there is no caloric to be consumed, the matter of heat whilst forming the vacuum had been extracted.

h. The luminous focus will be a little further from the mirror than that of light.

i. Melloni found that white lead absorbed heat as quickly as lamp black. Tyndal thinks that the dye stuffs have a great effect in the absorption of heat, in relation to the qualities of colours. This fact of the varying combination of caloric with different tints, points out that the principles forming or producing them owe their existence and qualities to imponderable matter.

j. Heat like light may be reflected, can undergo double refraction, be absorbed, and even polarized.

k. Glass permits light to pass freely through it, but stops for the greater part the heat, whilst rock-salt allows the calorific rays to permeate it freely. Thus rock-salt suffers 92 portions of heat to pass through it, glass 62, alum 12, sulphate of copper (0).

l. People have been known to bear a heat of 350° F.

m. Water has a much greater capacity for heat than oil, and is consequently longer cooling.

n. Probably 10 to 15 per cent of the heat radiated from the earth is absorbed within 10 or 20 feet of its surface.

o. Cast iron fuses at 2,000°, the temperature of the oxyhydrogen flame is 6,000°.

p. Snow absorbs heat faster than black cloth, and some white bodies radiate caloric more readily than black, and *vice versa*.

q. The railway bars between London and Manchester are sometimes 500 feet longer in summer than winter.

r. Heat is transmitted through wood with a velocity almost twice as great along the fibres as across them.

s. It would appear that no perceptible interval takes place between the time at which caloric quitted a heated body, and its reception by the thermometer.

t. Nothing but lava escapes from volcanoes, none of the exuviæ resemble the ingredients making up the rocks; &c., found in the different strata of the earth, showing that heat, &c., has either transposed the constituents of our globe, or that these volcanoes are very local.

u. The transmission of heat through a vacuum is another proof that caloric is a material element.

FLAME.

242. *Flame* (German *flamme*).—When the temperature of ignitible gases or vapours is raised very high and they come in contact with air, they are said to *burst into flame;* but, if previously mixed with a due proportion of oxygen or common air before ignition, then they *explode.* In the former case the combustion only goes on at the surface which touches the atmosphere and is quiet and gradual; but in the latter, every particle of the inflammable body being surrounded with the supporter of combustion, the inflammation extends instantaneously through the whole mass. The flame of the candle, &c., presents a hollow cone, the heat and light of which are confined to its exterior surface. A transverse section of such a flame exhibits a thin ring of light surrounding a central uninflamed core: the inflammable gas may be drawn by means of a tube, out of the central portion of the non-luminous part of the said flame, and can be lit as it escapes at the other extremity of the cannula. A flame may be extremely hot, without being proportionately luminous, as is the case with the flame of hydrogen, which is scarcely visible in daylight, but the heat of which is shown by introducing into it a fine piece of platinum wire, which instantly becomes white hot, and then emits abundance of light. The luminosity of all flames is of a similar origin, and depends upon *solid matter* ignited and rendered incandescent by the heat of the flame: thus if magnesia or lime in fine powder be projected into the flame of hydrogen, the luminosity of the blaze is immediately increased. Finely divided charcoal is the substance to which all common flames owe their luminosity. This material is derived from the hydrocarbon produced by the decomposition of oil, wax, tallow, &c., and also contained in coal gas; but, as charcoal, unlike magnesia and lime, is itself combustible, it not only renders the blaze luminous, but is burned in the act of so doing, passing off, in a well regulated and perfect flame, under the invisible form of carbonic acid gas. When flames are cooled, they

are at the same time diminished or extinguished; hence a flame cannot be made to traverse or recede through a metallic tube of small bore; and thus a flame may, as it were, be bisected by a piece of wire gauze held transversely across it: in which case, the smoke, gas, or vapour and charcoal go through, but not hot enough to inflame, having been cooled down by their passage through the metallic meshes; but by applying a blaze to the smoke thus produced, it may be again kindled. In this way the upper portion of the flame may be burned, while the ignition of the lower half is prevented by the interposed cooling medium.

243. *Ignition and Incandescence.*—These qualities express a property which bodies possess of giving out light at a certain point. The quantity of light thus emitted mostly increases with their temperature, at first it is *dim and feeble*, then *dingy red*, *red-hot*, *cherry-red*, *orange*, or *yellow*, and lastly *white-hot*. Incipient luminosity in a dark place is about 810°, a dull red visible in daylight 1000°, a full red is 1,200°, orange heat, 1,700°, and white 3,000°, and that of a wind furnace 3,300°.

It is doubtful if pure gaseous matter, under any circumsstances, is susceptible of becoming luminous; (showing that heat and light are two *distinct* material elements) yet it may be so hot as to ignite solid bodies. The brilliancy of the voltaic discharge, is owing to volatilized carbon. Burning phosphorus is very brilliant, and the phosphoric acid produced, if conducted into the flame of alcohol or of hydrogen, increases their luminosity. When the quantity of burning charcoal is too large, the flame smokes, or gathers in flakes. When coal-gas is poor, its brilliancy in burning can be increased by passing it through naptha. Flames to be effectual should resemble the light produced or excited into action by the sun, and like it, consists of a due admixture of the primary colours.

244. The influence of light of *one colour* upon external objects is seen, by viewing them through coloured glasses, or more perfectly by illuminating them by a monochromatic (one coloured) flame. We obtain an effect of this kind by a lamp fed with spirits of wine, burning in a wick impregnated with common salt, and which, as it produces little else than a yellow light has been called a *monochromatic lamp*. This flame causes red sealing-wax to appear as if yellow, and red morocco looks black, and so also do the brilliant blue of smalt and ultramarine. This result shows that colours like ponderable matter are capable of being reflected back after striking upon bodies,

in the same way that projected solids rebound from the surfaces they may have been propelled against. But to resume, in a common candle the wax and tallow is drawn, after being melted, into the burning wick, and is there converted into vapour, which ascends in the form of a conical column, and has its temperature sufficiently elevated to cause it to combine with the oxygen of the air, at a temperature equivalent to white heat. But this combustion, as before noticed, is very *superficial*, the flame being only a thin film of white hot vapour, enclosing an interior portion, which cannot burn for want of oxygen; this is shown by bringing down a piece of glass upon the flame, a ring of light may then be observed surrounding the interior dark part of the cone. In the middle of this flame we can place gunpowder or phosphorus and they will not inflame. We often see a red heat in the fire, but it is not hot enough to inflame the gas there present, as seen by being able to light it with a piece of paper, or by stirring the fire, thus admitting oxygen. The continued glow of the wick after the light is blown out, shows again combustion going on without flame. It is in consequence of the structure of flame, that we so materially increase its heat, by propelling a current of air through it by the blow-pipe. When spirits of wine is burnt *with flame* in the usual way, carbonic acid and water are the products of its combustion; but when consumed *without flame*, as with a heated spiral coil of fine platinum wire, it produces aldehydic and acetic acids. Flame, as before stated, will only pass through apertures of a certain calibre; this result ensues from the cooling ability of the wire-gauze being an excellent conductor and radiator of heat, and hence was employed by Davy in the construction of his safety-lamp, as now used by miners. Different substances when flaming emit dissimilar colours. Thus sulphur and carbonic oxide burn *blue*, wax *yellow*, and cyanogen *lilac*. What are the chemical conditions that determine these differences? We turn aside the flame of a candle by means of a blow-pipe, and a blue cone appears: why does it shine with a blue light? All common flames are incandescent shells, the interior of which are dark, and the relative quantity of light emitted depends on the temporary disengagement of solid particles.

245. Some chemists assert that the light emitted by flames is due to electric discharges; others regard light and heat as material bodies, which can be incorporated or united to ponderable substances, and that they may be disengaged as

chemical changes ensue. It is known that different substances emit light of dissimilar colours. Various facts tend perhaps to prove that all chemical combinations are attended by rapid vibratory motion of the parts of the combining bodies. which vibrations become more frequent according to the intensity of chemical action. The quantity of the emitted light, as respects its colour, depending like musical notes, on the frequency that the vibrations are accomplished, increasing in refrangibility as the violence of the chemical action becomes greater. The several parts of all material bodies are in a state of incessant vibration: that which we call temperature may then depend on the frequency or rather intensity and amplitude of those vibrations conjointly. If by any process, as by chemical agencies, we increase the foregoing to between 400 and 800 billions of undulations in a second, ignition or combustion results. In the case of the former of these numbers the temperature is 977° F.; at this heat the waves propagated in the ether produce red light. *This* also is the temperature of the innermost shell of a flame. If the frequency of the vibrations still increases, the heat correspondingly rises. and the light successively becomes orange, yellow, green, blue, &c., and this condition obtains perhaps in the successive strata of a flame, as we pass from the interior to its exterior superficies. The intensity of the radiations from flames becomes then diminished when brought near cold bodies, whether aerial or solid; the burning matter becomes chilled and consequently less intense.

246. *The flaming light emitted from magnets; as recognized by my own clairvoyants, and Baron Reichenbach's patients.*—The flaming light always waving over the magnetic poles of a bar-magnet, flickers and forms various curved and changing lines. It was observed that when the ends of a magnet were turned downwards the flame descended in the identical shape in which it flowed upward when reversed, and also extended laterally when directed sideways; if blown upon it behaved like any other flame, and when solid bodies were brought near, it was seen to curve round them. If a large glass lens was brought near the end of the magnet, the flame applied itself to it exactly in the same manner as happens when a sheet of glass is placed over the flame of a candle to blacken it. If the hand was held over the magnet, the flame passed between the fingers. *It follows from the foregoing, that the magnetic flame is evidently either itself something wholly material, or has such for*

a substratum. Miss Reichel, one of the Baron's patients, could mark the exact distance to which the magnetic flame spread over the table on which the bar-magnet lay, and it was found to extend to 19 inches. (*Reichenbach* p. 28, 9.)

247. It is to mutual chemical action we must refer combustion, and not call one or the other supporters of igneous action. Gases will not become luminous, as before noticed, by themselves, as seen in the hot air above the flame in a lamp-glass. There must be something to excite energetic action, as seen on introducing certain powdered bodies into the heated atmosphere in question. If there is not enough carbon in the flame of a candle, you get a blue light, and if there be too much a smoky flame is the result. Here the hydrogen of the burning substance first takes fire and lets fall the carbon, which brightens the light. We then of course want a solid body and another thing, heat, to produce a perfect flame, and we can accomplish this by igniting lime with a mixture of oxygen and hydrogen; during this experiment, no doubt part of the lime is thrown into a state of vapour. It should be stated that there is but a very small portion of the lime consumed. The flame thus produced is intensely hot and forms a perfect spectrum. The chief reason why a clear flame deposits a black mark on touching a cold body, is that the burning vapour is robbed of that heat which was necessary to form carbonic acid. Coal-gas has often too much hydrogen and too little carbon in it, hence the flame assumes a dull character, and the gas is said to be poor.

248. *Addenda (a).*—The shape of the flame, during the combustion of gases depends upon the heated air rushing upwards, and further the supply of hot vapour diminishes as the flame ascends, and eventually fails, hence the blaze of a candle gradually tapers to a point and then ceases altogether.

(b). When phosphorus is exposed to the action of common air, a kind of combustion takes place, and the smoke produced is found to be phosphorous acid, but when this substance is quickly burnt, phosphoric acid is the result. Here we have two different products, the sequence of a varying degree in the intensity of action.

(c). If the grains of gunpowder did not ignite progressively the cannon when discharged must burst, as would be the case if detonating powder, &c., were employed.

(d). The flashes produced in the burning torches on the stage, is effected by throwing the pollen or seeds of lycopodium (club moss) into the flame.

(*e*). When tapered pieces of charcoal are fixed to the poles of a large battery and brought near each other, the light produced by the approximation is so intense that all the elementary atoms in the air seem to be excited, as if by the light of the sun, and bodies placed within the stream are instantly melted, vitrified, dispersed, or decomposed. This stream of heat and light being quite independent of other bodies in its lateral proximity; of course the brilliancy and intensity take place even in a vacuum, or in nitrogen and chlorine gases, &c., and also in water, alcohol, and oils, &c.

(*f*). When the flame of a candle is placed between a positive and negative surface, it is urged towards the latter, but if the flame of phosphorus be substituted for that of the candle, it takes an opposite direction, and now tends to the positive pole. It has been noticed that inflammable bodies are always attracted by negative surfaces, and acid bodies and those in which the supporters of combustion prevail, are abducted by positive surfaces. Hence the flame of the candle throwing off carbon is directed to the negative, while that of phosphorus forming acid matter, goes to the positive pole, consistently with the ordinary laws of electro chemical attraction.

249. *Combustion.*—This term is generally applied to the phenomena exhibited by burning bodies, and which depend upon the rapid union of the combustible with oxygen and other gases. If a lighted taper be introduced into oxygen gas, it is very rapidly consumed with intense ignition and enlargement of the flame; and if it be previously blown out, so that the wick continues glowing, it immediately bursts into flame when plunged into the jar containing this gas. Sulphur which burns in common air with a small blue light, has its flame enlarged when emersed in a jar of oxygen, and the blaze is of a beautiful purple colour, dissolving, as it were, in the oxygen, and converting it into sulphurous acid gas, which becomes absorbed by water. Phosphorus, when inflamed in the atmosphere, burns with a bright light, but if consumed in oxygen, the eye can scarcely bear its brilliancy, and the heat which it evolves is very intense. Metals, when finely divided, burn with great intensity in oxygen; but their common oxidization is a slow process of combustion. It was once thought, because steam consisted of oxygen and hydrogen, that it would in burning produce great heat; but on trying it in too large a quantity, it extinguished the fire. It is generally stated that oxygen is a supporter of combustion; but this is merely a

relative term, for many inflammable bodies support combustion, as when you burn sulphur on red-hot iron. Again. if our atmosphere was coal-gas, then this, at present ignitible air, would be said to support combustion. Further, in using the flint and steel, you merely knock off pieces of iron which become incandescent as they pass through the air, after their electrical frictional application. If it was not for the form of iron and lead, they would be the most inflammable bodies in nature. According to the temperature at which you unite oxygen with phosphorus and certain metals. you get different acids of the one and oxides of the other. The presence of a piece of platinum in a mixture of oxygen and hydrogen will cause them to burn and form water. Gunpowder gives out heat and light, whilst passing from a solid into a gaseous state, as do fulminating bodies ; yet according to the theory of *latent heat*, cold ought to be the result. The rapidity of action has often much to do relative to the effects of combustion. Thus if you roll out a piece of the metal potassium, it becomes white and heated ; but if the action is chemically increased by putting this substance into water, we get both flame and light.

250. *Eremacausis* (decomposition) is the gradual combination of the combustible elements of bodies with the oxygen of the air. It is, in fact, a process identical with combustion, but not attended, in most cases, with sensible development of heat and light. This process is constantly going on in ignitible bodies exposed to the action of the atmosphere, and one of the first changes which takes place during decomposition of animal and vegetable substances is the unison of one or more of their combustible elements with oxygen, or its ultimate principles. The change of the elements of wood into the substance called humos (earth or soil), the formation of vinegar from alcohol exposed to the air, &c., depends upon eremacausis. The changes in colour, consistence, and other properties which vegetable juices, sawdust, leaves of trees, &c., undergo, when exposed to the atmosphere, are owing to the same cause. These changes do not take place when water is excluded, or when substances are at a temperature of 32°, all bodies requiring a certain amount of heat to enable them to combine with oxygen. It has been observed that, although nitrogen itself does not directly unite with oxygen, substances possessing nitrogen as one of their constituents, are subject in the highest degree to this process. Eremacausis differs from fermentation and

putrefaction from the fact that they cannot take place without the access of the atmosphere, through which means the oxygen is supplied to the decaying body. Although the terms putrefaction and fermentation are generally applied, the first to decomposing substances emitting odorous gases, and the second to decompositions emitting inodorous airs, it will be found that these processes are essentially the same, putrefaction going on in bodies containing nitrogen ; fermentation in substances without this gas. Although it is not uncommon for fermentation and putrefaction to be regarded as processes which may go on in bodies independent of external agents, yet in all cases eremacausis must take place previously to any decomposition in organic substances. The juices of fruit, or any other parts of a plant, which very readily undergo decomposition, retain their properties unchanged so long as they are protected from immediate contact with the air ; that is, as long as the cells or organs in which they are contained resist the influence of the atmosphere. It is not until after the juices have been exposed to the air and have absorbed a certain quantity of oxygen, &c., that the substances dissolved in them begin to be decomposed. The juice of grapes, which were expressed under the receiver filled with quicksilver, so that the atmosphere was completely excluded, did not ferment ; but if the smallest possible portion of air was admitted, fermentation immediately began. A remarkable and important fact with regard to this process is, that when this condition of intestine motion is once excited, the presence of oxygen is no longer necessary. The smallest particle of a body containing nitrogen gas in the act of decomposition, communicates the same state to the atoms in contact with it, and the whole mass thus becomes influenced by the first oxygenated, or *otherwise impregnated*, molecule. If the atmosphere be excluded after this process has commenced, the fermentation or putrefaction proceeds uninterruptedly to its completion. It is thus that a single particle of vegetable matter in a state of eramacausis will cause, by contact with other substances, fermentation and putrefaction, and upon this fact depends the necessity of adding yeast, or some other ferment, to saccharine solutions before fermentation will properly take place.

251. *Expansion* and *Contraction.*—This property is one of the most common and obvious effects of heat, which dilates or enlarges the bulk of every form of matter. Among *solids* the metals are the most expansile and contractile by heat

and cold. The expansibility of different *liquids* varies. Thus ether and alcohol are more expansile than water, and the latter more than mercury. Water instead of continuing to contract like other fluids, expands, and actually rises in the tube until it congeals. In this case, the expansion above and below 40° seems to be equal; so that water will exhibit the same bulk at 40° and at 32°. This is a wise economy of nature, for if water, like other fluids, went on increasing in density until it froze, the consequence would be that large bodies of water, instead of only being superficially frozen in winter, would be converted throughout into solid masses of ice, which the summer heat would never melt, and all life would become extinct. The earth being in winter warmer than the air, the heat is withdrawn from the surface by the cold breezes, and the whole body of water has its heat lowered at 40°, *which is the point of greatest density*, and a temperature perfectly congenial to fish and most other aquatic animals. The cold now continues to operate upon the surface of the water, but instead of diminishing its bulk, and rendering it *heavier* than the warmer water beneath, it *expands* and renders it *lighter;* so that under these circumstances a stratum of ice-cold-water (at 32°) will be found lying upon the mass of warmer water beneath it (at 40°). The retardation to the freezing of water will be proportioned to its depth that has to be cooled; and hence some very deep basins, or lakes, are scarcely ever covered with ice. Aeriform bodies and vapours are the most expansible forms of matter, and, unlike other bodies, they are all found to dilate and contract alike.

252. The capability of expansion is often employed in mechanics, as where the engineer brings the leaning walls of buildings into the perpendicular; by first heating the bars of iron, and then, after fixing, allowing them to cool. This quality of expansion and consequent contraction after the application of heat, must be attended to in constructing iron bridges, shoeing horses, and particularly when making astronomical instruments. The expansile ability of water when freezing can burst a cannon and split the rock.

(*a.*) *Relative to form.*—A solid glass rod expands more than when the same is made into a tube. Again, by giving a curve to the cast-iron plates, we prevent their cracking on their surfaces being exposed to variable temperatures. All bodies are more expansile at high than low temperatures.

(*b.*) Spirits of wine is six times more expansile by heat

than mercury; fluid carbonic acid is more dilatible than air; thus, heated from 32° to 86°, twenty volumes of this liquid increases to twenty-nine, which measure of expansion is four times greater than can be produced in air by the same change of temperature. Alcohol and bisulphuret of carbon, in the amount of their expansion by heat, although each of these liquids has a peculiar temperature at which it boils, "alcohol at 173°, sulphuret of carbon at 116°," still the rates of expansion from the addition, and also contraction from the loss of heat, are found to be uniformly the same in these two liquids, compared at the same distance from their respective boiling points.

(*c.*) Water may be cooled to 20° below the freezing point, in the fluid form, and still continue to expand, and the same when heated above 40°.

(*d.*) Rose's fusible metal, formed of two parts by weight of bismuth, one lead and one tin, expands up to 111°; it then contracts up to 156°, where it attains its maximum density, occupying less space than it does at the freezing point of water. It afterwards expands up to, and melts at, 201°.

(*e.*) The most expansible bodies known are liquid carbonic acid, sulphurous acid, iodide and chloride of nitrogen, one grain of which latter is equal to a barrel of gunpowder.

(*f.*) In France, where mill-stones are made, they cut portions of the rocks into cylinders several feet high, and then chisel grooves round them, and afterwards insert pieces of wood, which latter on being made wet, expand and separate the cylindrical portions of stone into pieces of the desired thickness.

(*g.*) Rumford, with 28 grains of gunpowder confined in a cylindrical space which it just filled, tore asunder, by expansible ability, a piece of iron, which would have resisted a strain of 400,000 lbs.

(*h.*) The ability with which bodies dilate is equal to that with which they would resist compression.

ANIMAL COMBUSTION.

253. There is always an evident relation between the quantity of oxygen or its ultimate constituents consumed by an animal, and the amount of carbonic-acid produced (the latter being usually less than the former). From this economy a greater or less proportion of heat is produced. It would appear that a greater analogy exists between the principal phenomena of respiration and those of the combustion of carbon, and this agreement in the results leads, in one sense, to the belief that the causes of both are similar if not the same. It was at one time supposed that the oxygen of the inspired air combined in the lungs with the carbon brought there in the blood, and thus produced the carbonic acid which was expired, occasioning at the same time a development of heat. But this theory is inconsistent with experiment, for it has been proved that the carbonic acid is not formed in the lungs, but that it is brought to them in the venous blood by the pulmonary artery, and that the office of the respiratory organs, is to disengage or get rid of it, while they at the same time absorb oxygen into the arterial blood. It is known that venous blood contains a great amount of carbonic acid, introduced into it by the capillary (hair-like) blood vessels of the general system, and the arterial blood is largely pervaded by oxygen, which latter it receives in the lungs and through the skin, both of which give out carbonic acid. If frogs or snails, &c., be confined in nitrogen or hydrogen gases, they will continue for a long time to give off nearly as much carbonic acid, as they would have done in common air, thus proving that this acid is not formed in the lungs and skin by the union of carbon with the oxygen of the air, brought into them by the venous blood, since there was no carbonic acid present where these animals were confined. This fact shows that the carbonic acid gas evolved must have been created by the natural economy of the confined creatures. Further, the quantity of oxygen taken in and carbonic acid given out by the body, bears mostly a

regular proportion to the amount of muscular exertion made use of by an animal. The oxygen combines with part of the materials set free from the muscles and system during their action, and forms carbonic acid, which is carried off by the lungs, skin, and mucous membranes, &c., of the organization. The only class of animals in which a constantly elevated temperature is kept up, are birds and mammalia. The bodily heat of the former varies from 100° to 112°, the first being that of the gull, the last that of the swallow. The lower the temperature of the air around, the greater is the ability of animals to generate heat within their bodies. In health the human temperature never sinks below 95°, but in asthma and cholera it has been known to fall to 20° below its standard; on the contrary in scarlet fever and tetanus it rises to 106° and 110°. As regards nurse-bees, these live insects can increase the local heat when the pupæ (oviform nymphs or insect chrysales) are about to come forth, by crowding together and becoming excited, they respire rapidly, even at the rate of 130 or 140 inspirations per minute. In one instance, the thermometer introduced among seven nursing-bees, stood at 92°, whilst the surrounding atmosphere was but 70°. In the month of May the local heat rose to 98° when the external air was only 56°. During September the bees are stationary, and then the hive is but a few degrees above that of the atmosphere. During the incubation of bees, these insects, by accelerating their respiration, causes the evolution of heat and the consumption of oxygen to take place at least twenty times as rapidly as when in a state of repose. The same results ensue in a degree sometimes with other creatures when hybernating. On confining animals in a given portion of air, the carbonic acid exhaled was found to vary according to the temperature; thus at 86° and 106° it was not much more than half that which was given off at 59° and 68° and only about two fifths of that exhaled at 32°. The quantity of carbonic acid produced during exercise, and for a certain time subsequently, and also after a full meal, is considerably increased; whilst on the other hand, it is greatly diminished during sleep. Thus a person who was excreting 145 grains of carbon per hour, whilst fasting and at rest, gave off 165 after dinner, and 190 subsequently to breakfasting and a walk; but he only excreted 100 during sleep. The variation in the general development of the body, and also with the sex and age is very considerable. For instance, it is greater in the males than females of the same age at

every period of life except childhood. In males the quantity increases regularly from eight to thirty, remaining nearly stationary until forty; thus it averages 77 grains of carbon per hour at eight years; 135 at fifteen; 176 at twenty; and 189 grains between thirty and forty. From forty to fifty there is a well-marked diminution, the average being then 156 grains; and the quantity is lessened gradually up to extreme old age, when the amount exhaled scarcely exceeds that of ten years of age; thus between sixty and eighty it was 140 grains, and in a man of a hundred and two it was 91 grains. These average results are widely departed from in individual cases; an extraordinary development of the muscular system being always accompanied by a high rate of extrication of carbon; and *vice versa*. For instance, a man of remarkable muscular vigour whose age was twenty-six, exhaled 217 grains of carbon in an hour, and another man at ninety-two, who in his younger days had possessed uncommon muscular abilities, exhaled 150 grains per hour. On the other hand a man of slight muscular development, at the age of forty-five, only gave forth 132 grains, and another at seventy-six exhaled about 92 grains. If we allow an animal to breathe a gas destitute of oxygen, the blood stagnates in the lungs and other parts of the system, from being loaded with carbonic acid, &c. When oxygen is not consumed by the capillaries in sufficient quantity, there will ensue, from want of the nervous energy being roused, gangrene (mortification); the application of great cold produces the same result. The burning of carbon in the capillaries or extreme blood vessels is one of the causes of the circulation of the blood, and accordingly as the economy is increased or decreased so are the number of the heart's beatings.

254. All organized bodies are liable to continual decay, even whilst they are most actively engaged in performing the functions of life; and one of the chief products of this decay is carbonic acid, which is especially given off after death, both in the plant and animal, and also abundantly at the period that precedes the death of the body, during which a general decomposition of the tissues is occurring. Thus plants as soon as they become unhealthy give off large quantities of carbonic acid, and also at the fall of the leaf. The same thing happens with animals in diseases which are attended with an unusual tendency to decomposition of the solids and fluids, such as eruptive fevers; at this

time the quantity of carbonic acid set free during respiration is greatly increased, although the body remains completely at rest; and notwithstanding this, the blood becomes dark, indicating that it has not been freed from the usual amount of the carbon, &c., which it has received from the tissues. If the blood comes to the lungs charged with carbonic acid, and is exposed in their cells to the influence of the air, which is a mixture of oxygen and nitrogen, an endosmose and exosmose of these gases through the pores of the tissues take place, according to certain fixed laws. The carbonic acid brought into the lungs from the system will pass out, to be replaced by oxygen and nitrogen, but the quantity of oxygen which enters will be much greater than the nitrogen, on account of the superior facility with which oxygen passes through porous membranes. Thus there will be a continual exosmose of carbonic acid and nitrogen, and a constant endosmose of oxygen and nitrogen. The exhalation and absorption of nitrogen appear usually to balance each other, so that the amount of this gas in the respired air undergoes little or no change. Now, as carbonic acid contains its own bulk of oxygen, it follows that the amount of oxygen absorbed exceeds that which is given off, by 170 parts in every 1,000, so that a quantity of oxygen equal to more than $\frac{1}{6}$ of that which is converted into carbonic acid is employed in the system, for other puposes. It may be that a part of the additional oxygen combines with hydrogen furnished by the food, or by the disintegration of the tissues, and that the water thus generated forms a part of that exhaled from the lungs, whilst another portion will be applied to the oxydation of the sulphur and phosphorus, &c., taken in with the food, which, after forming parts of the solid tissues, are excreted as sulphuric and phosphoric acids, &c., chiefly through the kidneys. In all these calculations, the enormous quantity of carbonic acid given off, and oxygen taken in by the skin, should not be forgotten.

255. *Muscular exertion contrasted with repose.*—The effect of bodily exercises produces a considerable increase in the amount of carbonic acid exhaled; both during its continuance and for some time subsequently to its cessation, the increase amounts to one-third the quantity given off during rest. If, however, the increase be prolonged, so as to occasion fatigue, it is succeeded by a diminished exhalation. The connection between muscular exertion and the carbonic acid expelled is most remarkably shown in insects.

256. *Sleep and awake.*—The carbonic acid exhaled during repose is less than when awake, being as 100 to 160.

257. *Digestive process.*—The exhalation of carbonic acid is greatly increased during digestion, and diminished when fasting; thus the hourly exhalation increased from 145 to 196 after breakfast, and from 111 to 188 subsequent to dinner. Alcoholic drinks *diminish* the exhalation of carbonic acid, especially when taken on an empty stomach. The quantity is also increased by exhilarating emotions, and decreased by depressing affections of the mind.

258. *Period of the day.*—There is an increase in the quantity of carbonic acid exhaled, in a general way, during the early part of the day, which lessens gradually until night time.

259. *As regards the economy of the liver.*—When the respiration is impeded from certain disorders, the liver becomes gorged with fat. This would seem to be occasioned by the want of elimination of the fatty matter through perspiration and the respiratory process, and the consequent accumulation of it in the blood, the burden of separating from the system the carbon is thrown upon the liver. Previously to birth this viscus is the only discarbonising organ in the body, the lungs being at that time inert; but as soon as the latter come into play, they then separate from the blood a large proportion of the carbon with which it is charged, and consequently less than is transmitted to the liver, which is made evident a short period after birth by the rapid lessening of this gland.

260. *Combustion of animal, oily, and muscular matter.*—Exercise and cold, by increasing the respiration, eliminates part of the fatty matter in the form of carbonic acid and water; whilst rest and warmth, by diminishing this drain, favour its passage into milk. The proportion of caseine (the principle of cheese), on the other hand, is increased by exercise, which shows that this ingredient is derived from the decomposition of muscular tissue. In Switzerland, where the cattle pasture is scarce, the animals are obliged to use much muscular exertion to obtain their food, and the quantity of butter yielded by them is very small, whilst the cheese is in a large proportion. But these very cattle, when stall-fed, give a large quantity of butter and very little cheese.

261. *Combustion of nervous matter.*—In the nervous as in the muscular system every vital operation is necessarily connected with a certain change of composition, so that no manifestation of nervous ability can take place, unless this mutation

can be effected. This change essentially consists in the union of oxygen, conveyed by the arterial blood, with the elements of nervous matter; and this union consequently involves the death and disintegration of a certain amount of the nervous tissue; the reproduction of which will be requisite, in order that the system may be maintained in a state fit for action. This reproduction is effected by the nutritive process, which takes place at the expense of other constituents of the blood; and will proceed most vigorously in the intervals when the active energies of the nervous system are not being called into operation.

262. *As regards perspirable matter.*—It appears that a complete suppression of the perspiration in animals, by applying varnish over their skin, gives rise to a state of cutaneous suffocation; which is marked by imperfect arterialization of the blood, and a considerable fall of the temperature; such an application soon produces death in the lower animals, and would probably do the same in man. A partial suppression of the action of the skin by the same means gives rise to febrile symptoms, and to albuminuria (albuminous urine).

263. The maintenance of animal heat is due in part to those molecular changes to which the cutaneous respiration is subservient, as seen where rabbits were shaved and coated with glue or suet. It might be supposed that by preventing the evaporation of sweat, the temperature of the tissues would be very sensibly increased, but it was *vice versa.* The heat of the first rabbit was, before the operation, 100°, but it shortly sunk after the application to 87, and in an hour to 76. In another rabbit, so prepared, by the time the plastering was dry, the temperature of the body was not more than 5½ above the atmosphere which was at that time 69°, and in an hour after this the animal was dead.

(*a*.) Digestion has been considered as a process of combustion, and the action between the elements of food and the oxygen conveyed by the common circulation of the blood (not forgetting that contained in the air swallowed during mastication and that taken up by the skin,) to every part of the body, has been regarded as one of the sources of animal heat.

(*b*.) When living animals are exposed to the direct action of oxygen the blood rapidly becomes very scarlet and loses its contained carbon.

(*c*.) Animals in a state of hybernation (winter sleep) produce no carbonic acid, and their temperature is not higher than the

surrounding bodies, you may wound and even give these sleeping animals electric shocks, and yet they will not awake.

If the carbon of the system was burnt in the lungs and skin would they not be warmer than any other parts of the body which is not the case?

ANIMAL HEAT.

264. Sir E. Home during some of his physiological experiments divided the nerves that supply the velvet-like skin of one of the horns of a deer, which operation diminished its temperature 7°, but after the lapse of 12 days the heat of the two horns was the same. Upon examining the structure of the parts after the animal's death, it was found that the interval between the divided ends of the nerves was filled up by a newly-formed connecting substance, capable of restoring their action. In further illustration of the effect of the nerves in producing heat, independent of mere circulation of the blood, Sir E. H. mentions a case of aneurism (morbid dilation of an artery) in which the large artery of the thigh was tied without occasioning any diminution in the heat of the foot.

265. Dr. Carpenter states that all the vertebrata have red blood, and the number of red corpuscles, which any given amount of the fluid contains, bears a nearly constant proportion to the ordinary temperature of the animal.

266. The calorification (act of producing heat) of living creatures throughout the animal kingdom, is said to be in exact conformity to the amount of oxygen consumed, and of carbonic acid given off, and the degree of heat liberated. Query, is not animal caloric mostly the result of electro-nervous action?

267. *Exercise as a source of animal caloric.*—In the higher animals, as in the lower, bodily exertion has a considerable effect in producing elevation of temperature, and that this is not merely due to the acceleration of the circulation, is shown by the fact that the exercise of a particular muscle will cause an increase of the heat liberated from it, as shown by needles plunged into its substance and connected with the thermo-mutiplier.

The quantity of carbon supposed to be consumed by living creatures will account for but little of the animal heat called into action by the bodily economy, but as we can set free or

develope caloric by electricity without combustion, so the nervous system may eliminate this element, or call it into action by the animal magnetic fluid pervading the system of living creatures.

268. Many young animals cannot retain their heat, hence to protect them, they must be kept warm. This economy probably ensues from want of nervous energy, and perhaps to the kind of sustenance they may obtain. It is generally found with the offspring which can run about in early life and supply themselves with food, that they better generate and preserve their bodily warmth. In starving animals it was noticed that they soon lost 93 per cent of their fat and the heat of the system rapidly sunk, but the nervous tissue did not appear to diminish in size. On applying artificial warmth to these creatures they all appeared to gradually revive. Relative to the human offspring, the heat of the fire failed to renovate the infant, but the warmth of the human body was successful.

269. *The temperature of warm-blooded animals.*

Species.	Of the body.	Of the blood.
Penguin	100°	—
Fowl	102°	106°
Sparrow	101°	107°
Swift	—	112°
Elephant	99°	—
Whale	—	102°
Squirrel	—	105°
Man	98°	100°

In the cold-blooded animals of northern climates the blood is only 32° or 34°. The range of the human blood varies but little, whether near the poles or in the tropics. It is found that there is about one degree difference, as to temperature, in the sleeping and waking state.

(*a.*) The gills of a fish are only its lungs turned inside out.

(*b.*) The brain of a shark is 30 times less than that of the porpoise. This has much to do with the superior temperature of the latter.

(*c.*) The blood of the alligator stands at 80° in the summer, in winter it falls to that of the mud in which it may lie.

(*d.*) As regards the penguin of the north, its blood is as warm as that of those which dwell in the south, or very nearly so.

(*e.*) Only one half the quantity of the blood goes through the lungs or gills of cold-blooded creatures in proportion to that which permeates the same organs in warmer animals.

PART IV.] SEPTEMBER, 1879. [PRICE SIXPENCE.

NEW VIEWS

OF

MATTER, LIFE, MOTION,

AND

RESISTANCE:

ALSO

AN ENQUIRY INTO THE MATERIALITY

OF

ELECTRICITY, HEAT, LIGHT, COLOURS, AND SOUND.

To be Published Monthly.

BY

JOSEPH HANDS, M.R.C.S., &c., &c.,

Author of "Will-Ability," "Beauty and the Laws Governing its Development," "Homœopathy contrasted with Allopathy," "A Dissertation on Diets and Digestion," &c., &c.

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PRELIMINARY REMARKS.

It is intended throughout the forthcoming work to point out certain novel characters in regard to the influencing attributes of MATTER—by displaying through particular facts—the true agency that the atomized and unatomized or ultragaseous worlds, exercise in the economy of Nature. Added to which, will be an investigation into some of the more abstruse Laws governing the various kinds of MOTIVITY. Also an inquiry touching the action of the LIFE-PRINCIPLE as it manifests itself, whilst governing the development of the vegetable and animal kingdoms. Further, the MATERIALITY of ELECTRICITY, HEAT, LIGHT, COLOURS, ODOURS, and SOUND, are considered, demonstrating that these principles have most of the characteristics of corporalities—save that of ponderability or weight. In addition, will be a disquisition touching the qualitative causes of RESISTANCE, and lastly will be annotations on GEOLOGY and ASTRONOMY.

LITERARY NOTICES.

We have been favoured with a perusal of a portion of Mr. Hands' Work on "MATTER, &c.," and can speak of it as a most able and interesting contribution to scientific literature.—*The Modern Physician.*—May, 1879.

Mr. Hand's Essays on Matter, Motion, Life and Resistance, &c., are replete with instruction and original conceptions of a very striking character.—*Human Nature.*—June 20th, 1879.

Mr. Hands, of Hammersmith, author of some very interesting works, has now adopted the plan originated by Dickens and Thackeray, whose books were brought out in monthly instalments. Mr. Hands's views are most original and illustrated by facts, his language stimulates the mental taste, like that of Robert Burton and Dr. Johnson, and pleases whilst instructing the reader.—*The Sussex Daily News.*—June 18th, 1879.

Mr. Hands has issued the second (July) part of his "New Views of Matter, Life, Motion, and Resistance." In many respects, this thoughtful and industrious author has trodden paths which are also explored by Dr Babbitt, in his great work on "Light."

These writers are pioneers in new fields of scientific research, and as such, a duty falls to their lot which cannot be attributed to a selfish motive. Mr. Hands is a true author, and gives to his readers profound original thought, at a popular price, his single object apparently being the education of the public mind in all its multitudinous forms.—*The Medium and Daybreak*, July 25, 1879.

(*f.*) The lungs of birds are small in comparison to some of the cold-blooded creatures, but then their brains are large in comparison to those of the latter. The brain matter of animals no doubt creates motion, and motion intensifies and calls forth heat, and both eliminate nervous electricity. Owen suggests that this result is from an electro-magnetic operation. He further states, that the air cells of birds extend to the ends of their claws and even into the featherlets of their plumage.

270. *Nervous and electro-magnetic sources of caloric in animals.*—Whilst a piece of charcoal is undergoing common combustion and at the same time placed in connection with the condensing plate of a gold leaf electrometer, the leaves of this instrument will be seen to diverge with free *negative* electricity, whilst the stream of carbonic acid escaping from the burning charcoal carries with it free *positive* electricity, this fact will account for the origin and ability of animal electro-magnetism to produce heat.

(*a.*) The Sicilian and Neapolitan eats and drinks much fat and oil, like the Greenlander, but the Englishman when in Italy and at the North Pole lives on as simple a food as when at home, and yet his blood is of the same temperature as that of the dwellers in the "sunny South or the frozen North.' Again, the reindeer subsists on lichens, and yet by this fat-free food, maintains its blood-heat equally with that of the Esquimaux, showing that breathing animals keep the same temperature of the blood in all climates. These facts demonstrate that the mere act of generating carbonic acid and water, quite fails to account for more than a moiety or portion of the animal heat of living creatures; its chief source then, no doubt, is derived from animal electricity and the constantly flowing polar magnetism of the earth.

(*b.*) Again, relative to the caloric developed in the different inflammations of the body, the combustion of charcoal in the animal system will not account for this economy.

(*c.*) Electricity in traversing the platinum wire, heats it red hot, and why should not the vital electro-magnetism in going through the nerves generate animal caloric?

(*d.*) By conducting a galvanic current through quicksilver we do not raise its temperature, but by passing a like stream through salt and water (which will represent animal secretions) the mixed fluid will soon boil. May not this result account for most of the animal heat called into action by the nervous influence?

(*e*.) A muscle whilst contracting contains less blood when in action than in repose, yet by putting a needle into it, the heat of this flesh-instrument will be considerably raised: this experiment shows that the muscle contracts, and at the same time its temperature is enhanced through the nervous energy.

(*f*.) The temperature of a palsied limb will be found to be inferior to the sound one. Mr. Earl had noticed that the heat of one of these diseased members was 70°, whilst the healthy leg ranged up to 92°, but on electro magnetizing the affected limb its temperature rose to 77°.

(*g*.) That there is a determination of animal electricity to a muscle when it contracts, was shown by Mr. Reymond, who states, that when the hands are immersed in two basins of water, in communication with the coil of a very delicate galvanometer, and the muscles of one of the arms is suddenly contracted, a current of electricity is developed, and can be detected by the movement of the magnetic needle. M. Despretez also found, that when a cylinder of platinum, or any other metal, in communication with a galvanometer, was held in each hand, and the fingers of one of them were suddenly contracted, so as to grasp the cylinder tightly, the needle of the instrument immediately deviated, often as much as 90°. Some persons suggested, that the heat of the hand produces this effect, but when the metallic bodies were lightly held, there was no action set up.

271. *Terrestrial electro-magnetism as a source of animal heat.*—It has frequently been noticed that many persons feel their feet grow cold after placing them for a time upon asphalte, though this substance, from its being a non-conductor of heat, is considered to economise animal caloric, but on the other hand it should be remembered that it also fails to transmit the ever flowing electro-magnetic fluid of the earth. Again, certain individuals, sometimes complain—and this especially when in the magnetic sleep—of feeling chilly, by reason of their feet becoming cold, when encased in silk or woollen stockings, or when standing for a period on a carpet, and especially when placed on oil-cloth. This result, like the former, is occasioned by being cut off from the earth's magnetism, for these sensitive persons state that they escape this impression when placed on wood or stone. In proof of the foregoing it is known, that if people are electrified, whilst isolated by being stationed on silk or woollen fabrics, that after the above operation, sparks can be attracted from their persons, as if they had rested on a glass-

stool during the electrical process. Now, had the above textures been moistened with water, on which the parties in question stood before proceeding to manipulate, you would have failed to charge and afterwards attract sparks from them, because the electricity would have escaped from their bodies through the wetted fabrics into the earth as fast as it was delivered to them.

272. Clairvoyants were always perfectly aware of the cause—why these persons felt chilly whilst located on the non-conductors, for they could perceive that the terrestrial electro-magnetism, that tends to keep up the action or renewal of animal heat, did not freely, or with its usual intensity, traverse the systems of the individuals in question.

Be it further noticed that some sensitive persons become oppressed, and even have their temperature much lowered, when standing near trees, and especially on entering a wood, and this latter result quite independent of passing into the shade. Here, again, clairvoyants affirm that the ever-constant stream of the earth's electro-magnetism is intensely attracted by, or impelled towards, the roots of the trees, from or through the surrounding soil, and rushes, or is conducted, up their stems, to be discharged from the twigs and leaves of the boughs, as from the points of an electrical-machine. In this way the persons under discussion became robbed, or deprived of the usual supply of the electro-magnetic fluid traversing the earth, and their appreciative feelings render them conscious of the deficiency. This latter fact dictates to us that we should not dwell too near trees or stalked plants, nor sojourn in forests. (See article "Electricity.")

273. *Further touching the development of animal heat.*—All vital actions require a certain amount of caloric for their performance. Thus, there is a slight increase of heat, as previously noticed, during the process of digestion; and exercise is an able means of raising the temperature of the body. Again, in disease the thermometer has been seen to rise, as before recorded, to 106° in scarlet fever, and 110° in tetanus (locked-jaw), whilst it has fallen to 82° in spasmodic asthma, and 77° in cyanosis (blue disease from malformation of the heart), and also cholera.

(*a.*) In the lower tribes of animals, in which the ability of locomotion is but feeble, and the supply of the wants of the system not immediately dependent upon it, very little more heat is generated than in plants.

(*b.*) The temperature of a muscle rises, as heretofore remarked, one or two degrees during its contraction, but that of the uterus (womb) during the parturient efforts, or labour pains, has been stated (by Dr. Granville) to be occasionally 22° above the natural standard, and to vary with the energy of its contractions.

(*c.*) With earth-worms, leeches, and mollusca (soft-bodied animals), the heat is never more than one or two degrees above the air and fluids surrounding them.

(*d.*) In the Lepidoptera (winged insects), the chrysalis, or oviform nymph, has itself the ability of generating heat at the period when its energies are aroused, and it is about to burst forth from its silky envelope.

(*e.*) The humble-bee, when confined in a bottle, has by violent exercise, in five minutes, been known to raise the confined air from two to four degrees.

INCUBATION.

274. Incubation (from *incumbo*, I brood over), the hatching or the lying down of an animal on eggs, communicating to, and maintaining them, at a temperature essential to their development. That a due degree of warmth is the essential object of incubation in birds, is proved by the practice of substituting artificial heat, by which fertile eggs are hatched in the same period as when produced by animal heat. The mean temperature in the process of hatching is 100° Fahr.; it may vary from 95° to 105°, and towards the close, the process may be suspended for one or two hours at a time. The ability of communicating the requisite degree of warmth to eggs, arises out of the unusual development and determination of blood to a particular plexus of vessels distributed over the skin of the abdomen (belly), and which, in most birds, is connected with a derivation of blood from the internal organs of generation, after the subsidence of the functional activity of the ovarium (egg-pouch) and oviduct to the external integuments. The vascular, hot, and sensitive condition of the skin of the abdomen, is the exciting cause of that uncontrollable propensity to incubate, which the Greeks denominate "*storge*" (love, affection), and which with its associated phenomena of patience, abstinence, and self-denial, form so remarkable a feature in the economy of birds.

275. There are sometimes found special provisions for imparting to eggs a temperature which is natural to the bodies of the parents; thus, in serpents, the heat of the posterior part of the body rises considerably when the eggs are lying in the oviduct, preparatory to being discharged, evidencing a special heat-producing energy in the surrounding parts at this period, which is obviously for the purpose of aiding the maturing of the ova. The viper, whose eggs are frequently hatched in the oviduct, so that the young are brought forth alive, is occasionally seen basking in the sun, in such a position as to receive the enhancing heat on the parts that covers the

egg-duct. Further, in order to hasten the development of the pupæ (the oviform nymph) of the social bees, a curious provision is made. The nurse-bees, whose duty is to cluster over the cells in which the pupæ are lying, communicate heat to them by developing it through the energetic movements of their bodies and rapid respiratory actions. These nurse-bees crowd upon the cells of the nymphs about ten or twelve hours before they come forth as perfect bees. During this kind of incubation, when one nurse-bee quits the cell, another takes its place; and the rapidity of the respiratory movement increases, until they rise, as before noticed, up to 130 or 140 per minute, so as to generate the greatest amount of heat just before the young bees are liberated.

VEGETABLE HEAT AND COMBUSTION.

In most plants, at the time of flowering, heat is generated, especially with those in which a large number of blossoms are crowded together, as among the arum tribe. Thus, a thermometer placed in the midst of twelve spadixes (inflorescences), has been known to rise to 121°, whilst the atmosphere was only 66°. Again, during germination, heat is also eliminated, as witnessed in the process of malting, during which operation the glass rises to 110°. The quantity of oxygen consumed, or rather resolved, into its ultimate elements by flowers, is often enormous; as, for instance, those of the arum italicum having been found to convert forty times their own bulk of that gas into carbonic acid, between the periods of their first appearance and final decay; of this, the far larger proportion is taken up by the sexual apparatus, which has been found to consume 152 times its own bulk of oxygen in 24 hours. I would here point out that the parts of the plant in question must have *created*, or *fabricated*, out of undeveloped, or unatomized matter, the ultra-gaseous matter of Professor Crooks, the carbon that combined with the oxygen, since the ponderable portion of the parts under discussion must have fallen very far short of the weight appertaining to the carbon furnished for the production of the exhaled carbonic acid.

But to resume. That the foregoing process is necessary to the production of heat is proved by the fact, that no caloric is evolved when the flowers are excluded from the contact o oxygen; and the substitution of this gas in its pure state, in the place of atmospheric air, occasions the elevation of the temperature to become more rapid. The same may be said o heat liberated by seed in the act of germination, for during this process a large amount of oxygen is absorbed and carbonic acid given out, and the evolution of heat may be easily shown to depend upon this change, as exemplified in the instance before quoted. The matter of caloric here produced or rather made evident, must have been in combination with the oxygen,

and was set free, when the ultimate elements constituting this gas united with the carbon created by the plant to form carbonic acid.

(*a*.) Humboldt states that the temperature of the bigonia radicans during inflorescence, is greater in the male than in the female plant.

(*b*.) The vital actions of certain plants are so adjusted as to be carried on within very wide extremes of heat and cold Thus a hot spring of water in the Manilla islands, which raises the thermometer to 187°, has plants flowering in it and on its borders. In certain springs of Louisiana at a temperature of 122° and 145°, have been seen growing not only confervæ (river weeds) and herbaceous plants, but shrubs and trees. A species of chara (flowerless plant) has been found growing and reproducing itself in a hot spring of Iceland, which boiled an egg in four minutes. Mr. Stanton states, that he saw in the island of Amsterdam a species of marchantia growing in a spring, the mud surrounding which was hotter than boiling water. On the other hand, there are some forms of vegetation which only luxuriate in degrees of *cold* which are fatal to most others. Thus the lichen, which serves as the winter food of the reindeer, grows buried beneath the snow ; and the beautiful little *protococcus nivalis* producing the red snow, crimsons extensive tracts of the Arctic regions.

(*c*.) Plants of small size vary in temperature with the atmosphere, but with large trees these latter are colder than the surrounding air in summer, and warmer than the atmosphere in winter, as seen by the snow melting round their roots.

(*d*.) The sap often flows in winter, but the interior of the tree, and the warm soil four or five feet deep, is mostly of the same temperature, which accounts for this economy.

THE EFFECTS OF HEAT ON ORGANIC AND INORGANIC BODIES.

276. Every species of plant requires the temperature which is most congenial to its economy, as exemplified in mountainous districts, the low valleys of which are frequently adorned with the vegetable products of the torrid zone, and the more elevated districts with those of temperate climates, while towards the summit, nothing is met with but the meagre natives of the polar regions; and the lines of demarcation are sometimes so remarkable, that on the volcano of Teneriffe no fewer than five distinct zones, marked by the products which characterise different climates, are distinguished.

(*a.*) Heat increases the quantity of evaporation from the surface of plants, and consequently the activity of absorption by the roots. The general processes of nutrition are thus carried on with vigour, so long as the plant is well supplied with water, which not only prevents its tissues from being dried up, but by its conversion into vapour, moderates the temperature which would otherwise be excessive. Cold depresses the vital action of plants, congeals their juices, and bursts the cells and vessels which contain them. Mr. Knight states that the cucumber and melon plants will afford all male or staminiferous flowers if their vegetation be accelerated by heat, and all female or pistilliferous, from the same points, if its progress be retarded by cold.

(*b.*) There are some species of cold-blooded animals, whose lives would be destroyed by a degree of heat which is but salutary to others, if their self-refrigerating ability did not resist its influence. Thus, the muscular fibre of frogs is so easily excited, that it would immediately pass into a state of permanent and rigid contraction, if bathed in a circulating fluid of the temperature of the blood of birds. But although a fluid medium of 140° is fatal to these animals, they are capable of sustaining the same heat in air for a long time without injury, as the rapid evaporation from their bodies resists its influence. Many men can bear a heat of 260° whilst the vapour of water

at 125°, or immersion in water of 113° cannot be continued for many minutes. On the contrary, fishes were found in the hot springs of Manilla, and in the thermal waters of Barbary at 172°. Humboldt relates that he saw fishes thrown up in the very hot water of a volcano, which, from their lively condition, was apparently their natural residence. Various fresh water mollusca are found in thermal springs, the heat of which is from 109° to 145°. Certain larvæ (insect grubs) have been found in hot springs of 205°, and small black beetles, which died when placed in cold water, were located in the hot sulphur baths of Albano.

(*c.*) Entozoa (internal animals) inhabiting the bodies of mammalia (suckling animals) and of birds, must of course be adapted to the condition of their residence, and the heat which they there support, from 96°to 108°, seems so natural to them, that they become torpid in a cool atmosphere. On the other hand, the Entozoa of cold-blooded animals seem capable of resisting not only cold but heat, for those inhabiting the intestines of the carp have been seen alive after boiling for the table.

(*d.*) A large proportion of warm-blooded animals pass the winter in a state of sleep. It is curious that in such cases extreme cold acts as a temporary stimulus. Thus, if a dormouse or other hybernating animal, already reduced to torpidity or numbness by moderate diminution of temperature, be exposed to a more intense degree of cold, its vital energies are aroused, as by any mechanical or other excitement, and it begins to execute the movement of respiration, by which its temperature is for a time elevated, but if the additional cold is continued it dies. On the other hand *heat* induces a state of inactivity in some animals: thus, the *helix pomatea* will become torpid and motionless in water at 112° and recovers its energy when placed in a cooler situation.

(*e.*) The motion of the green globules that are seen to circulate round the interior of the cells and tubes of some plants, as for instance that of the chara, is increased by a range of temperature between 55° and 77° Fahr., and decreased by a greater amount of heat or cold.

(*f.*) *Persistence of the vitality of animals.*—Insects have revived on exposure to the sun, after having been immersed in spirits for many months, and reptiles, fishes and caterpillars after being long frozen. The frogs of the Icy sea, that exhibited no signs of life when their legs were broken, resumed their natural movements, when exposed to a genial heat. The

larvæ of the cabbage butterfly have retained their vitality after being exposed to a temperature below zero. The eggs of silk-worms and those of slugs have been subjected to 40° below zero without injury.

(*g*.) Eggs may be brought to develope themselves by natural and artificial heat, as noticed under the head of Incubation.

(*h*.) A slight return of warmth will often set the sap in circulation; and in this manner the leaf-buds are gradually prepared during the milder days of winter, so as to be ready to start forth into full development in the spring. The gardener can, in some degree, invert the order of the seasons, and produce both blossoms and fruit from the plants of our own country, when all around seems dead. The process of *forcing*, however, is unfavourable to the health and prolonged existence of vegetation. The same result occurs when plants of temperate climates are transported to the tropics; within a short period after one crop of leaves has fallen off, a new one makes its appearance. Hence the fruit trees of this country transported to the tropics, produce foliage, but very little fruit, and the period of their existence is much shortened.

(*i*.) The influence of high temperature is evident in hot climates, as here ferns can develope a woody stem, and assume the character of trees; and it is only there that the tall sugar-canes, and the gigantic bamboos, which are but grasses on a large scale, can flourish.

(*j*.) For every species of vegetable there is a temperature which is most congenial, from its producing a favourable influence on its general vital actions. There is a considerable difference between the ability of *growing* and *flourishing*. We may lower the heat of a plant to such a degree as to allow it to continue to live, yet its condition will be unhealthy. Its tissues grow, but become distended with water instead of solid deposits. The usual secretions are not formed; flavour, sweetness, and nutritive matter, are each diminished, and the ability of flowering and producing fruit is lost.

(*k*.) Certain birds have recourse to substitutes for the usual method of incubation. Thus the *tallegalla* of New Holland is directed by *instinct*—or rather natural impulsive fore-knowledge, like that of the clairvoyant—not to sit upon its eggs, but to bring them to maturity by depositing them in a sort of hot-bed which it constructs of decaying vegetable matter. Again, the ostrich only sits upon its eggs in the absence of the sun's heat. One of our native fly-catchers was known to leave its nest, built in a hot-

house, when the temperature of the building was equal to the hatching of her eggs.

(*l*). It was found by Reaumur that pupæ which would not naturally have been disclosed until May, might be caused to undergo their metamorphosis, or transformation, during the depth of winter, by the influence of artificial heat; whilst, on the other hand, their change could be delayed for years by the prolonged influence of a cold temperature.

(*m*.) Certain terrestrial molluscs, and even particular fishes, like plants, enlarge greatly under the influence of heat; so, also, will some cold-blooded animals—as the frog, &c.,—which was proved in the experiments of Professor Edwards. On the contrary, cold destroys young animals—even children, and also old persons; pointing out to us the necessity of well clothing and keeping warm the aged and young.

(*n*.) Lead, which becomes heated by percussion, does not lessen in density, after the manner of iron, under the same process; yet, like the latter, it becomes hot when hammered.

(*o*.) Bismuth, unlike other metals, expands by the abstraction of heat in the same way as water, which dilates when solidifying into ice.

(*p*.) Caoutchouc (India-rubber) contracts by the application of caloric, but when putting it on the stretch, its particles become condensed, and heat is eliminated.

(*q*.) *Economising heat.*—In employing the self-acting Norwegian cooking apparatus, it will be found that if we boil meat for ten minutes, or roast it for a period, and then put it in the above thickly-felted box, it will go on preparing for meals, and will keep hot for 12 to 15 hours.

(*r*.) The same amount of caloric which serves only to raise water up to 75°, will heat oil to 83°. Oleaginous bodies cool in half the time that water does.

(*s*.) If we heat certain pieces of metal, each up to the same temperature, and place them on a cake of wax, the iron and copper will melt their way through first, and the tin next, whilst the lead and bismuth portions are retained on the surface of the cake.

(*t*.) The salts of nitre in dissolving reduces water from 50° to 35° Fahr.

(*u*.) Ice by compression will liquify; but on removing the pressure it will again become solid.

(*v*.) Liquifaction, as a rule, produces cold; on the contrary, congelation, or solidification of certain bodies, calls forth heat.

INFLUENCE OF CLIMATE, SOILS, AND FOOD, ON ANIMALS AND VEGETABLES.

277. (*a.*) Humboldt was among the first to promulgate philosophical views on local influences. Every hemisphere produces plants and animals of different species, and it is not by the diversity of climates that we can attempt to explain why equinoctial Africa has no laurineæ, and the New World no heaths, why the southern hemisphere alone produces calceolariæ and is without roses, and why Indian birds glow with colours less splendid than those of the hot parts of America; and finally why the tiger is peculiar to Asia, and the ornithorhynchus (bird-beaked mammal) to New Holland. Each small island in the Pacific Ocean, having precisely the same rocks and similar climate, is tenanted by a different set of beings. Australia produces almost only marsupial (having a pouch on the belly in which to cherish the young) animals, as kangaroos, wombats, flying opossums, kangaroo-rats, &c.—some living on herbs and fruits, whilst others are carnivorous, (feeding on flesh). The mountains of Peru and Chili are covered with lama, guanaco, and alpaca, which represent the genus camel of Africa. These are not found in Brazil or Mexico. A particular species of fox is indigenous to the Falkland Islands, and a singular kind of rat in New Zealand, which is locally destitute of other mammalia, except membranous-winged bats. Among the fertile islands in the Pacific, no quadrupeds have been met with, except the rat, a few bats, and the dog and hog, which latter may have been conveyed thither by the natives from New Guinea.

(*a.*) *As regards Birds.*—Those of the Brazils differ vastly from those of Africa, India, and New Holland. A single island sometimes contains a species found in no other spot on the whole earth; as seen among the parrot tribe. The grouse species of bird is found nowhere but in the British isles.

(*b.*) *As regards the Reptile Tribe of Animals.*—Of the great saurians (lizard family) the animals which inhabit the Ganges differ from the cayman of America, or the crocodile of the Nile.

(*c.*) *Relative to Snakes.*—We find the boa of America represented by the python of India and anaconda of Asia. Africa is the country of the poisonous cerastes or horned serpent. Asia of the hooded snake, or cobra di capello, and America of the rattlesnake.

(*d.*) There are no toads or snakes in Ireland, but they have the frog and water-newt, and green lizard. The same applies to North Wales.

(*e.*) There is not a single animal of the southern regions which is not distinguished by essential characters from the analogous species in the northern seas. The flying-fish are only in or near the tropics.

(*f.*) The common bee of this country was not known in North and South America, until the Europeans visited these countries. Plants, animals, and even mankind vary in their character, when transferred from one country to another. For example, the common European sheep when located in Africa became covered with a kind of hair.

(*g*). Dutrochet found that if he acidulated a weak solution of white of egg different species of manilea rapidly formed upon it, while if he rendered such a solution slightly alkaline, the Batrytis made its appearance, and that the solution in its simple state—neither alkalescent nor acidulated—produced no fungi. The horned poppy of the sea-shore, never grows spontaneously in an inland field, nor the marsh marigold on a dry heath, or the reindeer lichen of Lapland in the plains of a warm country.

(*h*). The nightingale is not found farther north than Yorkshire, nor westward than the eastern borders of Devonshire, though there are plenty in Somersetshire and Dorsetshire. This bird is neither found in Ireland or in Wales. Sir F. Heniker once took nightingales and their eggs from Surrey and Norfolk to see if they would frequent the woods of his estate in Devonshire, but the old birds forsook the locality, and the offspring produced from the eggs never returned to the place where they were hatched. The nightingale migrates in winter to Africa.

(*i.*) Toads according to Mr. Jesse are very numerous in Jersey, but they will not live if carried to Guernsey.

(*j.*) Species according to Humboldt are so local that they are found to be different on the east and west sides of the same country.

(*k.*) The form and stature of men differ as much as distinct species of animals. The arms, feet, and legs vary, and the stature from seven feet in the Pantagonian to four and five

feet in the Laplanders and Esquimaus, and still more diminutive among the Bosjesmen. The Gipsies and Jews preserve their family colours all over Europe, but cases are said to have occurred in America of negroes becoming white in their descent, and after generations still more fair in appearance.

(*l.*) In New Holland, nature is not only singular but reversed. Thus, swans are black and eagles white. The Kangaroo has five claws on its fore legs, and three talons on its hind extremities, yet hops on its tail; moles lay eggs, and have a duck's bill; a bird, the meliphaga (honey eater) has a feathered broom instead of a tongue. Pears are formed of wood, and the cherry has the stone on the outside. Every thing has an original character. All the quadrupeds are like the opossum tribe, the fish resemble sharks, and the very land and trees have peculiar features.

(*m.*) Rabbits do not burrow in hot climates, they place sentinels, like rooks and wild horses, to give warning of any danger.

(*n*). Italy abounds in leguminous (as the pea and bean) plants England in mosses, Germany in rushes and grasses, and Scandinavia in lichens.

(*o.*) Flowers of one climate do not unfold their leaves at the same hours as in others. Thus, an African plant, which opens at six o'clock, if removed to France, does not display its flower petals until nine, nor in Sweden before ten. Those which do not open in Africa until noon remain always closed in Europe.

(*p.*) Docks and nettles, sustained by certain animal substances, always follow man in his wanderings.

(*q.*) The entozoa and epizoa (internal and external parasitic animals) never infest, permanently, separate living species of animals.

(*r.*) Humboldt states, that the delicate races of dogs and our domestic cats, perish in a very short period when transported to the Cordilleras, 14,000 feet above the level of the sea, both the above animals die at the end of a few days, in convulsive fits. Humboldt likewise saw many of these chorea-like diseases when in Yauli, and supposes they occur from the deficiency of atmospheric pressure. The dogs of the Spanish colonies are hairless and are supposed to be of Chinese origin.

(*s.*) All mountaineers are mostly tall, athletic, and very handsome, in fact they often appear as if of a distinct race from those living in the valley.

ELECTRICITY.

278. *A disquisition touching the materiality of electricity.*— Previously to entering on the subject of electricity (of which there are two conditions, free and combined), I am impressed to put the query—may not the unequal distribution of heat and light, as regards the equatorial and polar regions, combined with the constant rapid whirling, and transitional motion of the earth,* also the incessant friction on its surface of the shifting winds and flowing waters with their constant vapourization and condensation, induce certain perpetual electrical currents to traverse our globe diamagnetically,—that is from east to west—similar to the polar magnetic waves, which are known to be ever *spirally threading* each other, as they undulate from south to north, culminating in the aurora borealis?

Admitting the foregoing economy to obtain, may it not be assumed, that it is through the action of these polar magnetic, and transversal electric currents, that all elongated bodies—when freely suspended—arrange themselves, either north and south, like the oblong loadstone, or tend east and west, corresponding to the warmer and greater diameter of the earth? Be it remembered, that it was from observing the obedience of pendent elongated gravitating materials to these operative laws, that Faraday was led to divide all substances either into polar magnetic or equatorial diamagnetic bodies.

279. As there are many dissimilar hues and musical tones comprehended under the general terms *colour* and *sound*, so there may be different modifications and kinds of electricity. In coming time, most probably, it will be discovered, that whatever varied *qualities* and *forms* this element of electricity may assume, or the effects it can work out, they will be found to emanate from the changing condition, or varying influence of one great principle.

* The earth in its orbit travels 1,632,000 miles in a day, or 68,000 miles every hour; it also turns upon its axis at the rate of 1,042 miles in an hour, or 25,000 miles each day. The sun moves over a space of 3,336,000 miles during the day, or 138,999 miles every hour.

Electricity may assume (so to speak) many distinct energies and qualities, in order to meet the continually changing economies of nature's requirements. Every individual thing in existence must be pervaded by this ever-operative imponderable material element, which will often be found to vary in some of its distinctive properties, according to the body it may for the time being influence or form a part of, whilst constantly escaping out of one object into or over that of another, as circumstances may become changed.

280. *Frictional Electricity.*—This phenomenon was first noticed, and afterwards described by Thales, 600 B.C. (one of the seven wise men of Greece), who discovered that a piece of amber, when rubbed, attracted light bodies. From this fact he supposed that the amber possessed a soul, and was endowed with animation and became nourished by the attracted bodies. The Indian children (as before noticed) on the banks of the Orinoko at the present day, according to Humboldt, amuse themselves with exciting, by friction, the dry and polished seeds of certain rushes, and afterwards attracting filaments of cotton or corn-husks with them. (See section 42).

Theophrastus of Eresos (the most distinguished of the pupils of Aristotle) 300 years after Thales, observed, that tourmaline had the ability of attracting light objects. If we warm large pieces of this varied-coloured mineral on a piece of hot iron, flashes of light may be seen to dash across its surface. If a crystal of tourmaline be mounted upon a pivot, or otherwise suspended, so as to be free to move, on exciting this substance so arranged, by blows or friction, polarity will be developed; one end being attracted by excited glass (as when rubbed by silk) and the other repelled. The polar arrangement of its particles exists throughout its substance, for when broken in two, each half will likewise prove to be polar. It is during the rise of its temperature that thermo-electric phenomena take place. These effects ensue also whilst this substance is cooling, but with the opposite direction of its qualities. Otto von Guericke constructed the first electric machine 1647, which was made of a globe of sulphur. The above first gleams of electrical knowledge seem to have been hidden in the long obscurity of ages, and nothing further was added to the observations of Thales and Theophrastus for 1,700 years, until Dr. Gilbert of Colchester, in the time of Queen Elizabeth, published a work on magnetism, wherein he mentions several new facts, attributed to magnetic excitement, and he gave to them the title

of electricity (from *electron*, amber). These recorded experiments drew the attention of later philosophers to this subject.

Electricity has, of late years, acquired much importance from its influence over chemical phenomena, and its connection with those of magnetism. When a clean glass tube is rubbed with a dry hand, or a portion of silk, it attracts and repels pieces of paper if brought near it. A stick of sealing-wax rubbed upon dry flannel, exhibits the same appearances, and to a superficial observer, seems to be exactly in the same state as the glass, and they are said to be electrically *excited*. But, on more close examination, it is found that when light bodies are *attracted* by excited glass, they are *repelled* by excited sealing-wax, and *vice versa*, so that the glass and wax are pronounced to be in *opposite electric states ;* and hence the terms of *vitreous* and *resinous* or *positive* and *negative* electricity. But these two states are always co-existent. Thus, when glass is rubbed by silk, the glass becomes positive, but the silk negative ; and sealing-wax rubbed by flannel, the wax is negative, but the flannel becomes positive. A similar excitation of electricity is seen in many other cases, as when we rub a cat's back with the hand, or when a piece of silk ribbon is drawn briskly between the fingers, or a sheet of paper rubbed with a piece of caoutchouc, and a metal rod by a silk handkerchief, or when breaking, striking, and bruising things. In fact electrical excitement is induced during every movement of matter, whether animal, vegetable or mineral. These and many other extraordinary phenomena connected with them, are hypothetically referred to the presence of a particular form of matter, called the electric fluid, which appertains to all bodies, but seems to become only evident when in redundancy or deficiency, and it may be, that its presence is made evident, only when the electricity of composition, or that traversing the superficies of bodies, is put into more or less intense motion by some local operation. Further, when the glass is rubbed with silk, the equilibrium of the electric fluid has been supposed to become disturbed, the silk is said to impart it to the glass, and hence the former, losing electricity, becomes *minus* or negative, and the latter acquiring electricity, becomes *plus* or positive. This is commonly called "Franklin's theory." Others have assumed the existence of *two fluids* as essential to the explanation of electrical phenomena ; both being equally subtile, elastic, and universally diffused, and each highly repul-

sive as to its own particles, and attractive of those of an opposite kind. Electrical quiescence is referred to the combination of these fluids, and their consequent mutual neutralization; and electrical excitation is the result of either being free or in excess. It is supposed that they are separated by friction, and by all those other causes which give rise to the appearance of free electricity. There are two distinct phenomena presented by electrified bodies, the one seems to result from the accumulation of electricity upon the surfaces of bodies; they are commonly included under the term of *electricity of tension*, and are well exhibited by the common electrical machine and its prime conductor. It affects or excites into action all neighbouring substances, and they are thrown by it into a polar electrical state by what is termed *induction*. It has a tendency to pass off in *sparks* (the supposed result of the combination of the two electric fluids) through the air, or gradually escape from points. The thunder storm furnishes a magnificent specimen of this state of electricity. The other condition of sensible electricity, is that exhibited by *electricity in motion*, as when a current of this fluid is passing through a wire or other conducting medium. In this case a vast quantity of electricity may be concerned in the phenomena, without any apparent intensity, but whilst the current is continuous, it produces magnetic results of a most extraordinary character; and when the perfect conductor is broken by the intervention of certain other media, they suffer in some cases chemical decomposition, and others become heated, and even ignited. The phenomena of electricity in motion are best exhibited by the voltaic apparatus.

In all electric experiments remarkable differences are observed in respect to the transfer of the electric fluid through different bodies. Some, such as the metals, allow its free passage through their substance, while others receive and retain it more superficially, as glass, resin, and other substances which exhibit attractive and repulsive abilities when rubbed. Hence the division of bodies into *conductors* and non-conductors. There are also *imperfect* conductors, as water, oils, vegetables, and animal bodies generally. The non-conductors are some times called *electrics*, and good conductors are named *non-electrics*. The electrics are likewise termed insulators. Thus, a brass rod mounted on glass or wax become *insulated conductors*. The insulators are also termed *dielectrics*. Thus, sulphur, lac, and glass have much higher inductive capacities

than air. Gum-lac insulates or detaches ten times as effectually as silk.

(*a*.) The dissipation of electricity by the atmosphere is nearly in the triplicate ratio of its moisture.

(*b*.) Black hair conducts better than white: all bodies are more or less conductors.

(*c*.) Electricity moves through copper wire with the velocity of four million feet in a second, exceeding that of a wave of light through space.

(*d*.) The shock of a Leyden jar (invented by Kleist, 1745) is transmitted from each end of an interposed wire and *arrives latest at the centre*.

(*e*.) An electric jar is discharged, if put into a vibratory state, as by sounding it like the harmonicon.

281. *Electroscopes and electrometers* are instruments by which changes in the electrical states of bodies are rendered evident and their intensities measured. One of the simplest of these consists of two small pith balls, as used by Dr. Gilbert, suspended by a very fine thread to the end of an insulated conductor. When this receives electricity the balls diverge, and the nature of the electricity by which they are separated is known by bringing near the conductor a piece of excited sealing-wax. If the divergence *increases*, it is the same as that of the wax or *negative*; if it *diminishes*, it is opposite to that of the wax or *positive*. Bennett's gold leaf electrometer is still more delicate. The leaves must be enclosed in a glass cylinder, sufficiently capacious to allow of their divergence. They are connected with a brass cap, which is used in the same way as the preceding. To ascertain the actual repulsive and attractive abilities appertaining to weakly-electrified bodies, Colomb's torsion *electrical balance* is used. It would appear by this electrometer, that the electric capability follows the law of gravitation, it being in the *inverse ratio of the squares of the distance of the acting bodies*. This instrument is affected by striking the cap of the apparatus with a silk handkerchief or from the wind of a bellows, probably from the friction induced.

But these instruments in question will only display one or two characteristics of the electricities belonging to certain substances; they will not demonstrate the very varied qualities and characters of the electric fluids appertaining to animate and inanimate things under varying circumstances. For instance, it will be found that animals in particular, when pervaded by certain feelings, have their electrical conditions

altered; and to detect these, we must employ the instinctive brain-electrometer of animals, especially that belonging to the human clairvoyant.

282. *Induced Electricity.*—As a general rule, no electrical *attractions* exist, except between bodies in *opposite* or *dissimilar* electric states. When any electrified substance, such as an excited stick of sealing-wax, is brought near other non-electrified bodies, they have a tendency to mutual attraction. This tendency exists among all surrounding substances; but such of course only as have freedom of motion are observed to move towards the excited electric: such as suspended feathers, particles of dust, &c. Now as these are *attracted* by the electrified body, it follows that they must previously be thrown into an *opposite* electric state by the mere *proximity* of the excited electric; and this is really the case. Whenever an electrified body is brought near to another in an unelectrified state, that part or surface of the latter which is opposed to the former, becomes oppositely electrical, and is consequently attracted by it. Electricity is thus said to be *induced* in the surrounding bodies by the vicinity of an excited electric: as, when a highly-electric cloud hovers over the earth, that portion of the land opposed to the cloud, becomes in an opposite electric state, and consequently attractive of the cloud. Thus, during a thunder-storm, we often see an electric cloud gather on the summit of a hill, and remain there until it has discharged its electricity, when it is wafted quietly away.

Dielectrics.—The term *dielectric* has been applied to the air or other medium, through which induction takes place, and it will be found that different dielectrics vary considerably in their respective inductive capacities; thus sulphur, lac and glass have much higher inductive capacities than air. When an electrified body approaches another which is in its ordinary state, the surface of the latter opposed to the electrified substance acquires an opposite state, this opposite electrical condition, however, only belongs to the opposed surface; for the other side or end of the body, though also electric, is dissimilarly so.

These results fully establish the fact that no two bodies, not even in their natural state, can be brought near each other, without acting on their inherent electricity, the slightest change set up in the one must be answered by the condition of the other, and no mutation, even in position, can take place in a proximate body, without electrical effects. Professor Daniel

came to the conclusion that no *distance* is so great that induction cannot take place through it.

283. *The electric light.*—The appearance of the electric light is modified by the density of the medium through which it passes. Thus, in common air short sparks are straight, or nearly so, and long ones zig-zag: the former are brilliant especially at their extremities; the latter are usually of a paler or redder hue. In *condensed* air, the electric spark is brightly white; in a rarefied atmosphere, it is of a reddish tinge, faint and divided: in the vacuum of a good air pump, it is of a purplish hue and only visible in the dark. In a good Toricellian vacuum the light is faint blue, and in the most perfect vacuum which can be obtained, *it is scarcely visible*, and of a greenish tint. In gases, the electric spark usually appears most brilliant in those which are dense. In hydrogen it is faint and red, in carbonic acid it is vivid and white. It is also modified by the nature of the surfaces from and to which it passes.

284. *Static or quiescent electricity.*—There is an important circumstance attending the distribution of statical electricity, which is, that it belongs to surfaces only, and is so far independent of quantity or mass of matter, that a hollow sphere receives the same charge as a solid one. Colomb found that an excited globe of metal afforded no indication of electricity in its interior. It has been concluded that in solid spherical bodies the electric fluid is accumulated on their surfaces, and everywhere equally, so that a spark, taken from any part of the surface, is of equal length, and the electricity has no tendency to escape from any one part more than another; its *intensity* therefore, is said to be every where equal. But if we alter the *form* of the body, we at the same time change this equal distribution of electricity on its surface. Thus, if two similar spheres be placed in contact, there will be two points of greatest and equal intensity on their opposite sides in a line with their point of contact, and at this latter point the electricity will be null. In an ellipsoid, the greatest accumulation will be at the extremities of the longer axis, and there the *intensity* of the electricity is at its maximum, and increases with the length of the axis, so that if the ellipsoid be considerably elongated, the intensity is very feeble at the equator, and very great at the poles; and in cylindrical bodies, the greater the proportion of the length to the breadth, the more will be the intensity of the extremities. If a conductor be elongated into a point, the intensity there becomes so great as to draw to itself, or favour

the escape of nearly the whole of the electricity; hence, wherever points project beyond the general surface, there is a tendency in the electricity to pass off from surfaces. If two balls of unequal diameters be placed together, the maximum intensity of the extreme point of the smaller sphere will be higher than that of the corresponding point of the larger, and by adding a series of balls in contact with each other, all gradually decreasing in size, the intensity will increase upon the smaller as the diameter diminishes. In consequence of this law of distribution, a ready dispersion of electricity takes place from all bodies of a pointed form, the intensity upon them increasing to such an extent, that the surrounding insulating medium of air gives way before it, and no longer suffices to restrain it.

The foregoing economies or phenomena may perhaps be explained by suggesting that the different or opposite terrestrial electricities, which are constantly traversing, diverse ways, over the earth, act upon the electric fluids resident in or upon isolated bodies, inducing in these static fluids the disposition to escape from the substances in question, and join the above ever-flowing electric currents. As regards the condition of the diminishing surface of elongated bodies, it should be borne in mind that the narrowing end of an isolated conductor has to convey the same quantity of electricity as its larger portion, and of course the in-dwelling electric fluid becomes condensed, and is thus rendered more elastically intense, and in this way its tendency to escape from or out of the said isolated substance must be enhanced. The influence of points in receiving and carrying off electricity is elucidated when a pointed wire is held to the prime conductor of the electrical machine, it rapidly and silently draws off its electricity, and sparks cannot be taken from it, while the point is in the neighbourhood, or if we attach a pointed wire to the conductor, there is the same convection of electricity; and on holding the hand near the point we feel a peculiar coldness, or wind, as it were, called the *electric aura:* it is often even sufficient to blow out a candle held near it.

285. *The electric fluid, like any other element, can be accumulated, demonstrating its materiality.*

(*a.*) In charging the Leyden jar, by means of the electrical machine, many hundred sparks may be observed to enter it, which, upon being discharged, are all concentrated into one, hence the brilliancy of its light, the loudness of the explosion, and the acuteness of the sensation it produces.

(*b.*) Electricity in the fluid form. (See proof of in Mr. Lake's experiments, section 54.)

(*c.*) Pyrogen (from the Greek *pur*, fire, and *gennaein*, to generate). This term has been lately applied to the electric fluid, in support of its materiality and existence as a chemical body. Water, according to Mr. Lake, consists of oxygen, hydrogen, and pyrogen, or electricity; this pyrogen, he suggests, is also in combination with oxides, and it was the depriving of potash and magnesia of this principle that enabled Davy to reduce them to the metallic state. It would also appear that it is a most important ingredient in acids, and that it forms ozone (from *ozo*, I smell) by combining with oxygen. Further, potassium, sodium, calcium, &c., and many other bodies are obtained by the abstraction of hydrogen from their oxides, by which means the affinity between them and oxygen is destroyed, and they are thus separated.

This discovery will produce an important revolution in chemical science, for if electricity or pyrogen enters into the composition of water, &c., it must also be a constituent part of every body into the formation of which this fluid enters, and by analogy must be an ingredient of all other entities. In explaining the experiments of Messrs. Schönbein and Gann with ozone, Mr. Lake deduces that zinc, nitrogen, and hydrogen, and most probably iron and copper, &c., *are not simple bodies*. He draws his conclusion as regards the metals, from the different colours of the flames in the experiments of Pollock and others on the ignition of metals in acid solutions, and in respect to zinc, the additional singularity of the odour produced by it when used as an electric in obtaining ozone.

(*d.*) It is found that *separate* portions of electricity can be taken out or off the surface of an excited resinous electrophorus (invented by Volta, 1775), by means of a carrier ball, which is found to become charged with a certain quantity or modicum of electricity after each contact, and this charge so obtained can be delivered over to a Leyden jar, and the dividends so taken up, by repeated charges of the ball, may be afterwards measured or calculated, by observing the length and intensity of the spark elicited on discharging the loaded jar.

(*e.*) When the electric fluid is passing along an insulated wire, the electricity can be seen escaping all along its course by induction.

(*f.*) As electricity produces mechanical effects upon matter (for instance, reducing the strong oak into splinters, and some

substances into powder, removing large blocks of stone, drill holes in metal vessels, and occasions earthquakes) it must be matter, as nothing of an immaterial nature can produce mechanical effects upon material bodies.

286. *Natural electrical phenomena.*—Electricity is called into action upon a grand scale, in the production of the thunder-storm. Franklin, in 1752, was the first person who proved that cloud-electricity was identical with that of the laboratory. He erected an insulated iron rod to conduct the electricity of the clouds into his house, and performed with it nearly all the experiments for which he had before employed the common machine; and that no opportunity might be lost of making such experiments, he attached a chain of bells to the electric rod, which gave him notice, by their ringing, of the electric state of the atmosphere.

Franklin's discovery led to the application of conductors to buildings and ships. These safety-rods should be *pointed* at each end and extend—the one extremity—above the highest part of a building, and the other should be made to penetrate deeply into the earth or be in contact with water. The upper point should be made of copper, because it does not ozydise. The conducting rod must be large to secure it from being melted by the electric fluid. Many persons independent of timidity, experience particular sensations and discomfort on the approach of a thunder-storm, arising from great sensibility to the influence of electricity. The best means of safety from lightning is, if out of doors, to avoid taking shelter beneath trees. When under electric clouds, take a recumbent position upon the ground, or shelter under sheds, carts, or any low buildings, and especially beneath the arch of a bridge. Avoid rivers and ponds, for they are good conductors, and the height of a human being when near them is likely to determine the course of the discharge. If indoors, stand in the middle of a large carpeted room. We should avoid the chimney, for the iron of and about the grate, the soot that lines it, and the heated and rarefied air it contains, may serve to conduct the lightning. Upon the same principle, gilt mouldings, bell-wires, and extensive metallic surfaces of any description, are also in danger of being struck. In bed we are comparatively safe, for feathers and blankets are bad conductors, and we are consequently to a certain extent *insulated* in such a situation.

The appearance of the sky during a thunderstorm, the manner which the clouds assemble, and attract or repel each

other, the circumstance of their rising against the wind, and traversing the upper regions of the atmosphere in a variety of contrary directions are indicative of the presence of electricity.

The causes of atmospheric electricity are chiefly vapourization, alterations of the state or form in the varieties of matter, changes of temperature, and chemical action, &c.

Another natural phenomenon, which may be referred to electric excitation, is the *waterspout*. It appears to result from the electric attraction of a mass of *gyratory* vapour or cloud, acting upon the water beneath. It first causes the appearance of a hillock in the ocean, the water is then drawn up by electrical attraction in a column towards the cloud. This gyratory motion of the electric fluids produces also revolving columns designated whirlwinds and sand-spouts. Volcanos when first forming have been known to produce water-spouts and whirlwinds.

(*a*.) *Falling stars* are of electrical origin, but sometimes these appearances are produced by aërolites (meteoric stones) also called bolides (native iron ores) or fire balls, which are very numerous when the earth is passing through the belt of iron-stones that revolve round the sun. The origin of these meteoric stones were very much doubted, and their existence, though attested by the ancients, was derided and even laughed at. Chladni, in 1794, was the first man of science that entered upon their examination. A *shower* of these stones fell in 1803 at L'Aigle, in Normandy; of these, 2,000 were collected, some of them weighing 17lbs. A meteoric stone was exhibited in London 56lbs. in weight, which fell in Yorkshire in 1795. Another shower fell in Benares, East Indies, some which were examined by Sir J. Banks. The aërolite recorded by Plutarch, and examined 500 years after by Pliny, was said to be as large as a waggon. Another fell in Alsace, 1497, weighing 270lbs. The stone found in Siberia, mentioned by Chladni, weighed 1,400lbs. Another was discovered in Buenos Ayres, S.A., that weighed 13 tons, a similar one was discovered in the Brazils weighing 14,000lbs. These stones chiefly consist of iron and silica.

(*b*.) Numerous instances are recorded of a quantity of black and red dust as having fallen, which covered great tracts of lands, before and after the descent of these air-stones.

(*c*.) The atmosphere is least electrical during the prevalence of *North-easterly winds*, and in that state of the air, which produces a disagreeable sensation of dryness and cold, without a corresponding depression of the thermometer.

(*d.*) Positive electricity is weakest during the night, increases with the sunrise, decreases towards the middle of the day, and again increases as the sun declines.

287. The principal phenomena of the disruptive discharge of electricity, depend upon the particles of the dielectric air (not having the ability of transmitting the electric influence through itself) yet it appears that some of the metallic molecules of the surfaces between which the electric fluid passes are carried with it in its course. Thus, when a spark takes place between a surface of silver and another of copper, a portion of the silver is carried to the copper and also a part of the copper to the silver. This fact reminds me of certain mesmeric and rubbing manipulation, during which process there is an interchange of the opposite electro-magnetic fluids, which pass from the one individual into or upon that of the other, and there is also reciprocally exchanged, particular animal elements, as shown by the invalid becoming strengthened and the operator feeling oppressed and at the same time inoculated, so to speak, with the pains of the patient.

288. The instantaniety of the light from the electric spark prevents us from seeing the motion of bodies, whatever be their velocity, as recognised when regarding the coloured revolving disc, the tints of which by common light cannot be seen, and the surface appears as if white, but by electrical light the whirling body seems at rest, and each colour is distinctly perceived.

289. *Electro-dynamics and other sequents of electrical action.*

(*a.*) Two parallel currents when directed the same way, attract each other, but when taking opposite routes they repel the one the other.

(*b.*) All moving elements, of whatever description, must call into action electrical results, the operation of which must produce local and even distinct changes and phenomena in the economy of Nature.

(*c.*) The electric fluid sometimes calls forth a particular odour and also a peculiar taste, by forming certain etherial compounds with oxygen, which are found capable of acting on the nervous system.

(*d.*) The taste of positive electricity is said to be acid, and that of negative electricity to be alkaline.

(*e.*) Ozone is the name given by Professor Schönbein to an odour evolved during the process of certain electro-chemical decompositions. It is also produced by common electric sparks,

and by the working of an ordinary electric machine in the air. (See "Pyrogen" sec. 285, *c*). It should be remembered that we have a distinct portion of brain-matter, the fibres of which appreciate odours. Thus, one person can smell a certain exhalation, whilst another individual may be incapable of ever detecting it, and this, from his being without the filament or nerve-loop that could recognise it. Again, for particular odours some individuals may have the fibre too sensitive so that the scent will produce uneasiness, faintness, and even pain. When this cerebral development in question becomes congested, and also when permanently inactive, then the individual so circumstanced becomes incapable of recognizing even the most offensive effluvias. (See article "Sound.")

(*f*.) Becquerel, Cross and Fox have by electrical induction of chemical action effected crystallization of mineral bodies, as carbonate of lime, quartz, arsenite of copper, and carbonate of lead, &c., &c., which are insoluble in any fluid which does not subject them to immediate chemical change.

290. *Aerial electricity.*—The electrical conditions of the air acts readily on the vegetable kingdom, thus, some plants close, others unfold their flowers on the approach of a storm. In a highly electrical state of the atmosphere, young shoots of various plants have been observed to elongate with extraordinary rapidity. Duhamel saw a young stalk of barley grow six inches, and a vine-shoot almost two feet during three days of electrical weather.

But this element does not appear to be capable of being applied artificially; though a gentle current, transmitted through a plant, seems to increase the exhalation from its surface, and consequently affects other vital processes. It is not unreasonable, however, to suppose that, as the different actions occurring in the system may require dissimilar degrees of the stimulus, that which is beneficial to some, may be injurious to others, and hence it is that the economy in general may not be advantageously influenced artificially. Electricity also excites certain of the animal functions, and many tribes of living creatures are peculiarly affected by changes in the electrical condition of the atmosphere; and almost every human being must be in some degree cognisant of them by his feelings.

The destruction of life by electric shocks is accounted for by the disturbance of the affinities between the component elements of the body, and the consequent immediate abolition of the vital properties of the tissues (especially the *nervous*, that

seems most affected by this agent) which may take place without any perceptible change of structure. In a thunderstorm in London in 1839, the vitality of a large proportion of the eggs, which were being artificially incubated in a machine for that purpose, was destroyed. On examination, the yolk-bag was found to have burst in the more advanced; and the vessels of the vascular area were perceived to have been ruptured in those of an earlier stage. The bodies of animals killed by lightning, or by artificial discharges, become more rapidly putrified than those of which life has been destroyed in other ways. Certain electrical and vital principles in animals prevent their being roasted alive, and flesh procured from recently killed animals, is much longer cooking (independent of its juices) than that which has been hung up for a period.

291. During fogs, and in the commencement of the falls of snow, I have, says Humboldt, seen through a long series of observations, the previously positive electricity rapidly pass into the negative condition, both on the planes of the colder zones, and in the Paramas (deserts) of the Cordilleras, at elevations varying from 11,000 to 15,000 feet. The alternate transition was precisely similar to that indicated by the electrometer, shortly before and during a storm. When the vesicles of vapour became condensed into clouds, having definite outlines, the electric tension of the external surface will be increased in proportion to the amount of electricity which passes over to it from the separate vesicles of vapour. Slate-grey clouds are charged, according to Peltier's experiments at Paris, with negative, and white, red, and orange-coloured clouds, with positive electricity. The negative electricity of the air, near high water-falls, is caused perhaps by friction and the disintegration of the drops of water.

292. *Detection of the presence of Electricity.*—An electrified ball placed in the centre of a large room, and equally removed from all surrounding objects, having irregularly formed conductors, electrified the particles of the air, and was detected by Faraday to a distance of 26 feet.

(*a*.) After breaking a roll of sulphur we shall find a charge of electricity upon its two surfaces, and if we pound it in a dry mortar and pour the fragments upon the glass of an electrometer, the leaves will diverge very forcibly, and if we renew the contact with fresh surfaces on a different plate, we shall find that it is not easy to deprive it of the whole quantity of free electricity it has thus acquired.

(*b*.) *Electrical clouds.*—During a thunder storm certain clouds are seen sailing in opposite directions, some attracting, others repelling their opponents, some glide with the wind, others against it, and when two come within striking distance, a stream of electricity passes, thunder is heard, equilibrium is restored, and then the clouds sail together before the wind.

(*c*.) The air—especially when dry— is a bad conductor of electricity, hence its retention on the earth's surface.

(*d*.) The burr on both sides of a card is occasioned by the passage of the opposite currents of electricity, the electric fluid also acts laterally, so as to thicken and shorten bodies an eighth or ninth along which it passes.

(*e*.) The electroscope is inactive in a wood, the conducting leaves and vegetation operating so as to annul the electro-magnetism of the atmosphere.

(*f*.) There is no thunder and lightning within the arctic or northern circle.

(*g*.) When a capillary tube is filled with water and fitted into a phial, also containing this fluid, and both are frozen, a flash of light proceeds from the tube. When different kinds of crystals are formed, flashes in like manner proceed from them. Again, when water is congealed into hail in the atmosphere, great electrical phenomena take place, and this storm is usually accompanied by flashes of lightning.

293. *Evidences of two electric fluids.*—If the wire carrying the current flowing *from* the machine, is passed over paper covered with a solution of nitrate of silver, it produces no change in it; but if the wire which conveys the stream *to* the instrument, when it is excited, be passed over the same paper, the salt of silver is decomposed. Negative electricity forms a round black spot on a paper charged with iodide of silver, but positive electricity developes a violet discolouration, in a radiated form, in all the filaments of the paper, amongst which it is diffused.

(*a*.) Gravitation is but a residual and comparatively feeble effort of the electrical energy, and the ability which electricity displays in effecting chemical combination, or separation, demonstrates that it really binds or loosens the atoms of which material bodies are composed.

(*b*.) Contrasted with magnetism, electricity is *cold and negative.* The electric fluid is mostly evolved from evaporation and chemical decomposition, and often emanates from the mineral beds of the earth. Again, whenever the temperature of the atmosphere is cold electricity abounds.

(*c.*) Bodies that *conduct* electricity possess in themselves but little of this fluid in their composition, on the contrary those substances that *do not* conduct electricity contain this element in abundance.

(*d.*) Matter, of every kind, is continually in motion, this activity, by excitation, changes the relations which subsist between the particles of bodies, and it is by these mutations that electricity is developed and evolved.

(*e.*) A highly electrified body when held near the cheek, gives the sensation of being touched by a cobweb, or resembles the impression produced by the near approach of the fingers of the mesmeriser.

(*f.*) On rubbing or exciting a particular substance, we impel into vivid action its natural inherent electricity, and when we present this stimulated body to another in its normal state, we arouse into operation the electricity resident in or upon the latter.

(*g.*) Electricity acts—as regards intensity—on bodies according to the squares of their distance from each other, but if millions of miles intervene between substances, this fluid still operates upon them.

(*h.*) A person can be loaded—when standing on a glass-stool—with electricity, so that his finger, when applied, can light escaping coal gas, yet this individual so charged does not feel its presence and his pulse is not hastened by a single beat.

(*i.*) Frictional electricity can be detected as it passes across the room by placing a needle on the electrometer; the effect is less on arranging the point towards the machine than when directing the head that way.

(*j.*) The same quantity of electricity heats *equally* a thousand inches of wire as it does one. This fact tells most positively against the *theory* of the quantity or amount of motion expended or "work done."

(*k.*) Dust or the small particles of bodies, discharges electricity like points.

(*l.*) The electric fluid that acts by induction: traverses space in curved or ellipsoid lines.

(*m.*) Heat produces no variation of the quantity of electricity required to effect a discharge across a given interval.

(*n.*) The electrical spark varies in colour according to the *media* it is passed through; thus, in air it is bluish, in nitrogen purple, in oxygen white, in hydrogen crimson, and in carbonic

acid green; and the sound produced by the spark, also varies when brought forth in different gases (See section 283).

(*o.*) Tyndall suggests, that by friction, the two electric fluids are torn asunder, the one clinging to the rubber and the other to the body rubbed.

(*p.*) People killed with lightning suffer no pain.

(*q.*) In addition to the electricity from friction and by induction we have, 1st. Electricity from the contact of dissimiliar metals. 2nd. From the juncture of liquids with metallic bodies. 3rd. By the contact of two substances varying in character. 4th. From chemical action as in *voltaic electricity*. 5th. Heat applied to dissimilar metals produces a continuous flow of electricity, also in heating and cooling certain crystals as in *thermo-electricity*. 6th. The motion of magnets and bodies carrying electrical currents, produce electricity as in *magneto-electricity*. 7th. Rubbing of sand poured on a metal plate. 8th. The friction of condensed water particles against the safety-valve or box-wood nozzle, as attached to Armstrong's hydro-electric machine, but this latter electricity (that is enormous in quantity,) is mostly contained in the steam, which is a compound of water, heat, and electricity.

(*r.*) A current of electricity produces, 1, chemical action, 2, heat, 3, light and magnetism, 4, dynamic effects, as in the mechanical and natural motion of materials.

(*s.*) According to Lord Stanhope, there is a return stroke after an electrical discharge (action and reaction always being opposite and equal). This return stroke in the case of lightning often proves fatal, even it is said, when from a great distance.

THERMO-ELECTRIC MAGNETISM.

294. The electricity resulting from heat, as made known by Mr. Seebeck in 1832, is that electrical sequent which can be readily excited forth in all metallic bodies, by disturbing the equilibrium of their temperature, the essential condition being that their extremities should be in opposite states as regards temperature. When two different metals, as copper and bismuth, are soldered together, an electrical current is developed. On heating the point of juncture of the two metals with a spirit lamp, or when part of a metallic bar is heated and the other left cool, an electric current is generated in its substance, which may be rendered evident, and its direction ascertained by the electrometer.

(*a.*) The thermo-electric properties of the metals have no correspondence either with their voltaic relations or abilities to conduct heat or electricity, neither do they accord with specific gravity, heat of composition, or atomic weights. They are, however, upon the whole, more evident in those metals which are most crystalline in their texture. In some cases, as with zinc and silver, the current of electricity increases up to a certain temperature of 250°, it then ceases, and on increasing the heat re-appears in a contrary direction.

(*b.*) *Thermo-electric circuits* may be formed with substances of lower conducting ability than the metals, as with cylinders of porcelain clay.

(*c.*) Melloni constructed a *thermo-electric pile* of thirty-six pairs of small plates of bismuth and antimony, and attached to it a sentient galvanometer; it was so susceptible of changes of temperature, and, therefore, so delicate a *thermascope*, as to be affected by the warmth of the hand, held at a considerable distance from it.

(*d.*) The thermo-electric current will occasion convulsions in the limbs of a frog, but is inadequate, in its primary state, to affect any kind of chemical decomposition.

(*e.*) When a weak electric current is transmitted through a bar of equal length of bismuth and antimony soldered together; from the antimony to the bismuth heat is evolved at the point of juncture, but if in the contrary direction, cold is the result.

GALVANO-VOLTAIC ELECTRICITY OR CHEMICAL ELECTRO-MAGNETISM.

295. The phenomena resulting from the evolution of electricity by chemical operation are manifested in the action of the voltaic battery, and also when two different metals are brought in contact. The existence of the electric current and its direction may be rendered evident in various ways; the most striking is, perhaps, afforded by the galvanometer (invented by Ampère, 1820), which is a magnetic needle poised upon a point, like the sailor's compass.

In 1790, Galvani of Bologna discovered* that electric sparks taken in the vicinity of a recently killed frog, produced spasms of the muscles; and it was soon afterwards found if the sciatic nerve of the same animal be laid bare, and touched with a piece of *zinc*, whilst, at the same time, the muscle is placed in contact with *gold*, similar effects to those of electricity were produced whenever the metals were brought into *junction*, or connected together by *conductors*. If non-conductors were used to join the metals, no spasm ensued. It is found that cold-blooded animals retain this kind of excitability longer after death than other creatures; and they are observed to be affected by states of electricity so feeble as not to be indicated by the most delicate electrometer. When a live flounder is placed in a plate, with a slip of zinc under it, and a piece of silver on its back, it will be seen that on connecting the two metals by means of a bit of wire, that at each contact strong muscular contractions are produced. If a piece of silver be placed *upon* the tongue, and a plate of zinc *under* it, no effect is observed whilst the metals are kept apart; but if their edges be brought into contact, we immediately perceive a saline taste, also a very slight electrical shock, and often a flash of light appears before the eyes. This experiment was known to Sulzer fifty years before Galvani's discoveries.

* This experiment was first noticed in 1789 by Signora Galvani whilst preparing some frogs, to make a stew with, for a sick friend, and she pointed out the fact to the professor, her husband.

Again, if two metals be allowed to touch each other, whilst the tongue is intervening, it will be found capable of deflecting the magnetic needle. In reference to electrical excitation by the contact of different metals, immersed in very dilute acids, it is found that the most oxidisable metals is always *positive* in relation to the least oxidisable, which is *negative*, and the more opposite the metals in these respects, the greater the electrical effect. Here we have presumptive evidence in favour of a chemical cause as the source of electricity, for it is not produced by the most dissimilar *conductors* either of heat or electricity, but by those which are most opposed in the facility with which they are acted upon by oxydizing agents, and it will be, moreover, found that upon this *chemical action* the direction of the current entirely depends. So that, for instance, if copper, in contact with iron, be placed in dilute sulphuric acid, the oxydising agency of such aqueous acid will be limited to the iron, and the electric current will be from the iron to the copper; but if we substitute a solution of sulphuret of potassium for the sulphuric acid, the chemical action will then be greatest upon the copper, and the direction of the electric current will be reversed.

There are two circumstances which materially interfere with the quantity of electricity put into motion. The one is the *size of the plates*, and the other the *nature and strength of the interposed acid or liquid;* or, in other words, the nature and energy of the *chemical action.* By increasing the superfices of the plates, the extent of the chemical action of the intervening fluid is enhanced, and the quantity of electricity proportionately augmented; and in the case of zinc and dilute sulphuric acid, the more rapidly the zinc is oxydised, and the oxide removed, so as to expose successive new surfaces to the agency of the intervening acid, the greater is the quantity of electricity which traverses the circuit.

Electro-galvanism overcomes the most able chemical attractions, as shown by Davy (in 1807), who submitted the fixed alkalis, which were considered at one time as elementary bodies, to the agency of the galvanic current, and was fortunate enough in this, his first trial, to obtain from them new elements; at the positive pole oxygen was evolved, but brilliant metallic globules appeared at the negative pole, extremely inflammable, and which were shown to be the bases of those bodies. The names *potassium* and *sodium* were given to these new and singular metals; and by analogically applying these

N 2

phenomena to the decomposition of the alkalis to that of the *earths* (also then on the list of elements), they likewise afforded evidence of decomposition, and, like the alkalis, were shown to be combinations of peculiar metals with oxygen; thus, the metal calcium was discovered to be the base of lime, &c. Mr. Daniel, with an able battery, formed by the galvanic current a continuous arch of flame, between two pieces of charcoal, three-quarters of an inch in length; this flame was dangerous to the eye, even if protected by coloured glasses producing when reflected from an imperfect parabolic mirror in a lantern, inflammation and scorching like that of the sun; the rays were collected into a focus by a glass lens, and readily burned paper at many feet from their source. No spark could be made to pass from one electrode, or pole, to the other (even when only separated by the smallest stratum of air). The arch of the flame *was attracted and repelled by the poles of a magnet*. The intensity of the heat on the side of the positive pole was much greater than that of the negative.

296. *Effects of the galvanic current on the magnetic needle.*—Every part of a wire when in connection with two opposite plates of a galvanic battery, is capable of exerting a very able action upon the magnetic needle. If the needle be allowed to take its natural position, under the directive influence of the earth, and the wire is placed above it in a parallel direction, the end which points to the north being directed towards the silver plate of the battery, that end will move towards the west, and the needle will tend to place itself across the wire; but if the wire be placed below the needle, the same pole will move eastward, and across the wire in the opposite direction.

297. *Identity of voltaic and common electricity.*—Faraday has arranged electrical phenomena for the purpose of this comparison under two heads; namely those with electricity of *tension* or intensity, and those connected with electricity of *motion;* the former includes attractions and repulsions at sensible distances; the latter (or the effects of electrical *currents*) includes the production of heat, magnetism, chemical decomposition, and physiological phenomena. Electricity in motion through the voltaic apparatus, produces heat, magnetism, chemical decomposition, shocks, and under certain conditions, sparks.

298. *Effects of galvanism on the animal system.*—Humboldt brought on severe inflammation by applying the current to a small wound, and Volta asserts that the negative wire commu-

nicates the greater pain. A flash of light is perceived by covering the bulb of the eye with tinfoil and forming a metallic communication with the mouth. Berzelius found an acid taste on dipping the tongue into a zinc vessel containing water, which was placed on a silver stand, by touching the silver with his hand, so as to complete the circuit. If the negative pole is communicated with the tongue, its taste is caustic and alkaline.

(*a.*) When the battery is applied to a nerve of a person recently dead, and the circuit is completed, several violent motions ensue, dependent upon the relative position of the nerve and muscles; thus, if the wire communicates with the phrenic (from *phrenes* gr. the diaphragm or midriff) nerve, the muscles of respiration are set in motion, when the ulnar nerve of the arm and spinal marrow is included in the circuit, the fingers are set in quick motion, &c.

(*b.*) When the secretion of gastric (from *gaster*, gr. the stomach) fluid was suspended by cutting the eighth pair of nerves, the digestive fluid was restored by establishing a galvanic current through the divided parts of the nerves next the stomach.

(*c.*) Each pole of a battery excites particular phenomena in organs of the body to which it is applied. The positive pole more particularly influences the muscular and vascular systems, while the negative pole especially affects the nervous system. At the positive pole there is felt the shock, also strong movements, likewise a feeling of concentration and contraction, increased warmth and mobility of the part, with gradual diminution of the secretion and sensibility. At the negative pole the pain and sensitiveness are stronger and more acute, the organ expands and is very irritable, while the muscular action and mobility are lessened. The difference of their action on the secreting energies is best seen by applying the respective poles to a surface which has been recently deprived of its cuticle, such as where a blister has been produced. The positive pole changes the serous secretion into that of lymph, which at last becomes thready; the part inflames, drys up and then heals. The negative pole causes an abundant secretion of a dark-coloured, highly acrid fluid, which excoriates the skin over which it flows, the part also experiences an enduring irritation. Relaxed swellings are rendered harder, should they not become inflamed by the positive pole, while frequently by the negative pole they are dispersed and resolved.

(*d.*) *Electrical currents appertaining to mineral veins.*—By inserting into the mass of a copper *lode* a metallic wire, which shall be connected with any measurer of a galvanic action, and a second wire also from the instrument being in contact with another *lode* near it, an immediate effect is generally produced, showing that a current is traversing through the wires from one lode to the other. The currents thus detected are often sufficiently active to ably deflect a magnetic needle, and to produce slow electro-chemical decomposition and also render a bar of iron magnetic.

(*e.*) There is a rapid absorption of oxygen around every galvanic apparatus, as appears by immersing a glass jar over a pile, and the air so disappears that the water rises and the oxygen of the air is gone. In this respect the galvanic action resembles combustion and respiration.

(*f.*) The zinc of a battery is the generating metal of the galvanic fluid and copper the receiving. The electricity passes with the sun from east to west, or from the positive to the negative poles.

(*g.*) A telegraph can be formed by sinking a copper and zinc plate deep into the earth, and being connected with wires, the circuit will be completed through the damp earth, and this to any distance.

(*h.*) Acids can be made through the agency of electro-galvanism to traverse alkaline solutions, without combining with them, and *vice versa.*

(*i.*) It is to Professor Volta, of Pavia, in 1800, we are indebted for the first voltaic pile and the discovery of an electric excitement being the result of the contact of two dissimilar metals, by the meeting of which *natural* or *common* electricity was decomposed, the positive fluid passing to one metal and the negative to the other, showing that the muscle of a frog was merely a conductor.

MAGNETISM.

FACTS TOUCHING THE MATERIALITY OF THE MAGNETIC ELEMENT.

299. *Historical details relative to the discovery and use of the magnet.*—There are certain native oxides of iron that are termed *magnetic iron ores*, which have the property of attracting iron filings. The Greeks called this mineral *magnetos*, from the name—as it is said—of a shepherd, who first observed its attractive phenomenon. The adducent property of this ore was referred to by Homer, Aristotle, and the Arabians. Pliny describes this mineral under the name *magnes*, a term supposed to be derived from Magnesia, a province of Lydia, where the ore abounded, and was known to the Greeks 1,000 B.C

There is an account of the magnet in the Chinese dictionary A.D. 121. Ships were steered by the Chinese sailors A.D. 419. We have some curious descriptions of the *leading-stone* or loadstone, in the works of an Icelandic historian, who wrote in 1068. The mariner's compass is also described in a French poem of the date of 1181, and from Torfœci's History of Norway, it appears to have been known to the northern nations in 1266, and to Roger Bacon in 1294. Vasco de Gama, a Portuguese navigator, employed the compass in 1497, in his first voyage in the Indian seas.

The discoveries of Oersted, Arago, and Faraday have established a more intimate connection between the electric tension of the atmosphere and the magnetic tension of the earth. Whilst Oersted noticed that electricity excites magnetism in the neighbourhood of the conducting body, Faraday's experiments have elicited currents from the liberated magnetism. Magnetism is one of the manifold forms under which electricity reveals itself. The ancient presentiment of the identity of electric attraction, has been verified in our own times. "When electrum" (amber) says Pliny, "is *animated* by friction and heat, it will attract bark and dry leaves, precisely as the loadstone attracts iron." The same words may be found in the

literature of an Asiatic nation, and occur in an eulogium on the loadstone by the Chinese physicist Kuopho. Thus he states that—"The magnet attracts iron as amber does the smallest grain of mustard seed. It is like the breath of wind which mysteriously penetrates through both and communicates itself with the rapidity of an arrow." These are the words of Kuopho, a Chinese panegyrist on the magnet, who wrote in the beginning of the 4th century.

The incessant change, or oscillatory motion, which we discover in all magnetic phenomena, whether in those of the inclination, declination and intensity of these energies, according to the hours of the day and night, and the seasons, and the course of the whole year, leads us to conjecture the existence of very various and partial systems of electric currents on the surface of the earth.

300. If a bar of *tempered steel* be rubbed in a certain direction with a *loadstone*, it is itself rendered permanently *magnetic*, and acquires properties similar to those of its source. No other metal, except nickel and cobalt—not even soft iron—can receive and retain *permanent* magnetic properties.

(*a.*) The most obvious qualities of the magnet are, 1st, polarity; 2nd, attraction of iron; 3rd, repulsion and attraction of another magnet; and 4th, the production of magnetism in iron by induction or investiture.

(*b.*) *Polarity.*—If a slender bar, or needle of steel, rendered magnetic, be poised on a central point, or suspended by a thread so as to have free motion in a horizontal plane, and to be uninfluenced by neighbouring iron bodies, it will for a time oscillate to and fro, and ultimately settle nearly *north and south;* this is called the *magnetic meridian*, and constitutes *magnetic polarity*, and the ends of the needle are called *north and south poles.*

(*c.*) *Mariner's compass.*—This instrument was known to the Chinese 1115 B.C. Their method was to place it on a small piece of cork and set it to float on water. The compass was brought to Europe by Marco Polo, a Venetian. Flavio Gioja, of Amalfi, a navigator of Naples, is said to have introduced the suspension of the needle in 1302. Its variation was first discovered by Columbus 1492. The compass-box and hanging needle were invented by William Barlowe, an English philosopher, 1608. The *measuring* compass was invented by Joot Bing, of Hesse, 1602. According to the purposes to which this instrument is applied, it becomes the *azimuth compass,*

the *variation compass*, and the *mariner's compass*. Relative to this latter, Guyot de Provence, in the 12th century, speaks of the loadstone, to which he gives the name of *marinetti*, or mariner's stone, as useful to navigation.

(*d.*) *Attraction of iron.*—On bringing either pole of a magnet near a small piece of iron, it will be attracted; and if iron filings are used, they will cluster about the poles. From the way in which the filings adhere to a magnet, it is found that the great attractive ability is near the extreme ends, as at its *poles*, and that it diminishes towards the centre, at or near which no attraction exists. These attractions are, of course, *mutual*; that is, the iron attracts the magnet, and *vice versa*.

(*e.*) *Attraction and repulsion of another magnet.*—If we bring the pole of a magnet near another which is poised, it will be found that if two *similar* poles be presented to each other, they exhibit a mutual repulsion; but the two *dissimilar* poles mutually attract each other. Here, therefore, we observe an analogy between magnetism and electricity, inasmuch as *between similar energies there is repulsion*, and *between dissimilar controls, attraction*.

(*f.*) *Magnetic induction.*—If a bar of iron be brought near a magnet, the iron acquires temporary, or *induced magnetism;* and here, again, analogy to electric induction will be observed. If we heat an iron bar up to bright redness, and then bring it near a magnetic needle, it will not affect it; but as soon as it is cooled down to a common red heat, the magnetic ability gradually returns, and is stronger than in the cold iron; but there is one particular period during cooling—between the white and red heat—at which the induced polarity is inverted, or in which the iron attracts the needle the contrary way to what it does when cold. We also find that the permanent magnetism of a steel needle is diminished by a moderate heat, and that a red heat totally destroys it.

301. It is obvious, from the position assumed by the magnetic needle when freely moving in a horizontal plane, that there is some attractive energy in the earth, which causes it to assume a constant direction, and that what we have termed the north pole of the magnet, is attracted towards the north pole of the earth, and its south pole by the south pole of the earth, and hence it is inferred, according to the above stated law of magnetic attraction, that the poles of the earth are in an opposite magnetic state to those of the needle. But the earth has also a further influence upon an artificial magnet, for in

our northern latitudes the north pole of the suspended needle is attracted *downwards* as well as to the north, and assumes a position almost vertical, this inclination from the horizontal plane is called *the dip of the magnetic needle*. When a bar of iron is held nearly vertical, its ends are no longer indifferently attractive of a poised magnet; but (so long as it continues in or near that position) it is *polar*, the *lower end* of the bar being a *north pole* and the *upper end* a *south pole*, and it affects the magnetic needle accordingly. We now need only place the bar in a *horizontal* position, and both ends attract indifferently the poles of the needle; or, in other words, the induction of the earth is neutralized and vanishes. It is not uncommon to find bars of steel, which have long remained in a vertical position permanently magnetic, that is, *polar*, this is often the case with the poker and tongs. There is a mode of making a magnet dependent upon the same cause, which consists in holding a bar of steel in the direction of the magnetic dip, and striking it whilst in that position a few smart blows with a hammer; the upper and lower ends then become south and north poles. If a bar of steel already magnetised, and not in this position, be similarly treated, it loses its magnetism.

(a.) The magnet, like the charged electrical conductor, loses none of its original ability while communicating this induced energy, but, on the contrary, it has its own state exalted by the *reaction* of the opposite energy it thus developes.

(b.) If we fracture a magnet or loadstone into any number of pieces, each fragment will be a perfect magnet with contrary poles.

(c.) When the poles of a magnet is not in use they are connected together by a piece of soft iron, that is called the *keeper*, by which their energies are preserved unimpaired, in fact they become increased by exciting reaction in the magnet by completing the circuit.

(d.) Mr. Scarby's great magnet rendered an iron nail weighing 500 grains magnetic by induction, at a distance of 11 inches, so that it supported another piece of iron weighing 389 grains. It also sustained a nail weighing 194 grains *through* a slab of marble seven-eighths of an inch thick.

(e.) It appears from the latest researches to be probable that there may be more than one magnetic pole in either hemisphere. The magnetic equator, moreover, does not exactly coincide with the terrestrial equator, but appears to be in an undulatory or irregular *curve*.

(*f*) The direction of the needle varies even in the same place, thus, in the beginning of the 17th century, the needle in London inclined a few degrees to the eastward of the true north, but in 1659 it pointed exactly north, and after this line of no variation, began to travel slowly westward, and has now passed over to North America. The needle is also subject to diurnal variations of small amount, thus the needle attains its maximum of easterly variation between seven and eight in the morning, it then moves westerly until about two p.m., when it attains its westerly maximum, it then returns easterly again till the evening, after which a slight westerly motion succeeds, and this is followed by a return easterly during the night. The greatest amplitude takes place in England during June, July, and August. These variations doubtless depend upon changes of temperature. Robert Norman, 1576, first noticed the dip of the magnet; he previously to magnetizing the needle accurately balanced it on a pivot, after it became a magnet it could no longer be poised on the same point without attaching a small weight at the south extremity.

A needle will become magnetic when exposed to the violet ray of the spectrum. Captain Ross, 1831, reached a spot in North America in the polar seas, which had been calculated to be the position of the magnetic pole. There he found the dip of the needle to be very nearly vertical, and compass needles suspended in the most delicate manner exhibited no polarity.

(*g.*) A scarabeus or sacred beetle, made of loadstone, was found in an Egyptian mummy (from *mum*, wax), which, although upwards of 4000 years had elapsed since it was taken from the rock, still retained its attractive magnetic virtue.

(*h.*) The magnetic energy is not sensibly affected by the interposition of any substance, except those containing iron or steel, it attracts equally through glass, wood, paper, water, or in the exhausted receiver.

(*i.*) Small natural magnets will sustain more than large ones in proportion to their weight. It is rare to find a natural magnet weighing 20 or 30 grains, which will lift more than 30 or 40 times its own gravity, but a minute piece of natural magnetic ore, worn by Newton in a ring weighing three grains, lifted 746 grains, or nearly 250 times its own weight.

(*j.*) A ship in the middle of the Atlantic being struck with lightning, had the polarity of all her compasses reversed. This being unknown, the ship was directed as usual by the

compass, until the ensuing evening, when the stars showed that the direction was in the exactly opposite course from what it was intended.

(*k.*) In repeating Mr. Somervill's experiments (of exposing needles to the violet rays of the spectrum and blue glass, &c.), M. Baumgartner discovered that a steel wire, some parts of which were polished, while the rest were without lustre, became magnetic by exposure to the white light of the sun; a north pole appearing at each polished part, and a south pole at each unpolished portion. The effect was hastened by concentrating the solar rays upon the steel wire. In this way may be obtained eight poles in a wire eight inches long. He was not able to magnetize needles perfectly oxidated, or completely polished, or having polished lines in the direction of their lengths. Professor Barlocci found that an armed natural magnet which could carry 1½ Roman pounds, had its energy nearly *doubled* by 24 hours exposure to the strong light of the sun. M. Zantedeschi found that an artificial horse-shoe magnet which carried 13½ oz., sustained by three days exposure 17 oz., and at last supported 31 oz. by continuing the sun's light. He also noticed that while the ability increased in oxidated magnets, it diminished in those which were not oxidated, the diminution becoming insensible when the magnet was highly polished. He now concentrated the solar rays upon the magnet by means of a lens, and then found that both in oxidated and polished magnets they *acquire* strength when their north pole is exhibited to the sun's rays, and *lose* ability when the south pole is exposed.

(*l.*) If a horse-shoe shaped bar of soft iron is rendered magnetic by the circulation of an electric current around it, and its two ends are united by an armature also of soft iron; while the current is passing it is capable of supporting many hundred pounds. It will likewise be found that a considerable weight may be supported when the current is stopped, provided the armature is carefully kept in contact, and it will retain this ability for many years; but remove the armature (the piece of iron connecting the ends of the curved bar of iron) and it immediately loses all magnetism, and will not now support even the armature itself. This fact appears to confirm the idea that magnetism is due to the retention of electricity, and that steel possesses the property of equalizing the opposing energies or rather the ever-flowing magnetic current of the earth, which was established or brought by induction into play,

whilst the stream of electricity was passing through the iron circle, was broken by moving the armature.

(*m*.) The attractive ability of the magnet is less in the tropics than when we approach the poles. The greatest attractive energy on the earth's surface, according to Ross, is at the south pole.

(*n*.) In artificial magnetism the effect is as the surface, and just as in electrical conductors, a hollow magnet and a solid one of equal surface has a similar ability of lifting a piece of iron, &c.

(*o*.) Davies, in his history of the compass, has proved that the Chinese used it under the name of Tche-chy (directing stone) 2604 years B.C.

(*p*.) On rotating a 13-inch mortar shell and other bodies by means of a lathe, it deflected the needle, and on reversing the motion the compass was turned in the opposite direction.

(*q*.) While the cholera was at it height in St. Petersburgh, the action of the magnet was nearly neutralised. A magnetic block which used to carry 80lbs. would not support 13lbs. Further, the electro-magnetic telegraph would not act, but when the epidemic ceased the magnets assumed their usual ability.

(*r*.) The metal lodes that run north and south are always the purest and richest.

(*s*.) The compass is protected from the influence of an iron ship by placing soft iron near its compartment.

(*t*.) Oxygen that is strongly magnetic, becomes diamagnetic when heated ; nitrogen that forms four-fifths of the atmosphere is in one sense like a vacuum, it is neither polar or paramagnetic nor diamagnetic.

(*u*.) A magnetised needle suspended by silk acts like the compass when held over a magnet, and dips at the north and south poles.

therefore, to *revolve* round the electric current in a direction from *east to west*, or from *right to left*. These results led Faraday to conceive that the pole of the magnet ought to revolve about the electric conductor, and the latter round the pole of the magnet; his after experiments proved that this was the fact, and from that discovery a great variety of rotatory electro-magnetic apparatus has been contrived, in which the electric and magnetic currents are mutually made to produce the revolutions of conductors about each other, and round their own axes.

Terrestrial magnetism.—All the principal effects of terrestrial magnetism may be imitated by distributing a wire round the surface of an artificial globe in a spiral direction from the equator to the poles, the two extremities being turned inwards and brought out at the two axes by which the connection may be made with the battery. A magnetic needle properly suspended in different situations near such a globe, will arrange itself in positions analogous to those actually assumed by the dipping needle in corresponding regions of the earth.

The above experiment most positively proves that there are polar and equatorial currents of the electro-magnetic fluids *constantly* traversing around the globe we inhabit.

MAGNETO ELECTRICITY.

306. The production of electricity by magnetism is the converse of electro-magnetism; for the knowledge of this electrical science we are exclusively indebted to Faraday.

In the statements relative to electro-magnetism, it is evident that magnetism is produced by electricity in motion; from this fact it occurred to Faraday, that magnetism in motion ought to produce an electric current, and he succeeded in verifying this conclusion as follows: a long, spiral coil of copper-wire, covered with silk, was connected by its extremities with the galvanometer, the deflection of which would of course announce a current of electricity in the spiral and wires connected with it. He found that in the act of introducing the pole of a bar-magnet within the coils of the spiral, a deflection of the galvanometer took place in one direction, and in the act of withdrawing the bar it took place in the opposite course, so

energies. Thus, he demonstrated that luminous rays could be magnetised and attracted like ponderable matter, and he also showed that undulatory controling magnetic lines could produce illumination. He further proved that all kinds of matter were magnetic. Thus, he demonstrated that every substance placed between the poles of an efficient magnet, is influenced in one of two ways: it either takes a position coincident with the polar magnetic energies, as is the case with a bar of iron, and other bodies usually called magnetic, or it places itself at right angles to the line of these polar energies, as is the case with a bar of glass, of bismuth, and apparently of every other body; the former of these substances Mr. Faraday distinguishes as magnetics, the latter as diamagnetics, and their respective positions between the poles are termed *axial* and *equatorial*, that is, tending north and south, or pointing east and west.

ELECTRO MAGNETISM.

305. *Evolution of magnetism by electricity.*—This discovery was made in 1819, by Œrsted. All effects resulting from this process depend entirely upon *electricity in motion*, or *electric currents*, and are directly proportionate to the *quantity* of electricity. Nothing of the kind is produced by the electricity of *tension*, nor are they apparently increased by augmenting the *intensity* of the current. Hence for their development, voltaic electricity is more effective than common electricity; and those forms or conditions of the voltaic arrangements which are calculated to produce *quantity* rather than intensity, are required; hence also *perfect metallic contact* of the conductors employed must be observed.

When a wire transmitting the voltaic-electric current is brought near a magnetic needle, it has the ability of attracting and repelling it. If we stand with the face towards the north, and the current of electricity passes along the wire in the same direction, that is, from the south to the north (parallel with the magnetic meridian) then the compass, when *above* the electric current, will turn to the *left*, or to the *west*, and when placed below the current, to the right or *eastward*, its *north* pole will be *elevated* when on the *east* side of the current, and *depressed* when upon the *west*, and will have a tendency,

PRELIMINARY REMARKS.

It is intended throughout the forthcoming work to point out certain novel characters in regard to the influencing attributes of Matter—by displaying through particular facts—the true agency that the atomized and unatomized or ultragaseous worlds, exercise in the economy of Nature. Added to which, will be an investigation into some of the more abstruse Laws governing the various kinds of Motivity. Also an inquiry touching the action of the Life-Principle as it manifests itself, whilst governing the development of the vegetable and animal kingdoms. Further, the Materiality of Electricity, Heat, Light, Colours, Odours, and Sound, are considered, demonstrating that these principles have most of the characteristics of corporalities—save that of ponderability or weight. In addition, will be a disquisition touching the qualitative causes of Resistance, and lastly will be annotations on Geology and Astronomy.

LITERARY NOTICES.

We have been favoured with a perusal of a portion of Mr. Hands' Work on "Matter, &c.," and can speak of it as a most able and interesting contribution to scientific literature.—*The Modern Physician.*—May, 1879.

Mr. Hand's Essays on Matter, Motion, Life and Resistance, &c., are replete with instruction and original conceptions of a very striking character.—*Human Nature.*—June 20th, 1879.

Mr. Hands, of Hammersmith, author of some very interesting works, has now adopted the plan originated by Dickens and Thackeray, whose books were brought out in monthly instalments. Mr. Hands's views are most original and illustrated by facts, his language stimulates the mental taste, like that of Robert Burton and Dr. Johnson, and pleases whilst instructing the reader.—*The Sussex Daily News.*—June 18th, 1879.

Mr. Hands has issued the second (July) part of his "New Views of Matter, Life, Motion, and Resistance." In many respects, this thoughtful and industrious author has trodden paths which are also explored by Dr Babbitt, in his great work on "Light."

These writers are pioneers in new fields of scientific research, and as such, a duty falls to their lot which cannot be attributed to a selfish motive. Mr. Hands is a true author, and gives to his readers profound original thought, at a popular price, his single object apparently being the education of the public mind in all its multitudinous forms.—*The Medium and Daybreak*, July 25, 1879.

that each time the conducting wire cut the magnetic curves a current of electricity was, for the moment, produced in it. Further by making the poles of a horse-shoe magnet revolve rapidly before a soft iron armature, supplied as in the former case with a helix, or what is still better, causing the armature and helix to revolve before the poles, an electric current is obtained, which not only gives continuous sparks, but ignites wire, decomposes water, and produces strong shocks.

The magneto-electric machines under certain forms are now employed for the medical application of electricity. The instruments at present in use were constructed after the plan of the one originally invented by M. Hipolyte Pixu of Paris, which was first shown at the meeting of the Academie des Sciences, in 1831.

MINERAL ELECTRO-MAGNETISM.

307. This form of electricity is chiefly recognised as belonging to the different kinds of crystals, but most especially to the mineral designated loadstone, one of the oxides of iron mixed up with the metals nickel and cobalt, and also quartz, and alumina, the latter being the base of the clays.

Dr. Ashburner following up the experiments of Baron Reichenbach, was accustomed to set up certain magnetic batteries by glueing the bases or negative ends of translucent natural crystal-stones to a piece of board. He would then place some of his sensitive patients before the apices or positive extremities of these pellucid minerals, which generally, in a few minutes, by their magnetic influence, sent them to sleep. He found (as did the ancient Eastern temple therapeutæ) a like result when exposing his patients to the action of the loadstone. I myself, with many other persons, have produced strange effects on individuals in their sleep-waking state, especially with the diamond and emerald. Clairvoyants would at periods ask for certain precious stones to increase, as they declared, their perceptive abilities, and they would sometimes order that particular sick persons should wear rings set with a certain gem to hasten or promote their cure.

The priests in ancient times wore gems set in their breastplates, which were thought to produce venerative feelings in

their followers, and also caused the pythoness or prophetess and the soothsayers of the "Temples" to predict or foretell the truth. These breast-plates set with precious stones, were first worn in India, and afterwards used in Egypt, from whence the Jews had or copied their Urim* and Thummim†, under the influence of which the high priest gave oracular answers to the people.

VEGETABLE ELECTRO-MAGNETISM.

308. That electricity is resident in and upon plants and their products, may be shown by rubbing different seeds on certain textile fabrics; and that it forms part of their secretions, can be demonstrated by friction applied to some of their secernments as the inspissated products of the turpentine tree and also resinous amber, for after undergoing this process they will be found capable of attracting light bodies, such as small fragments of paper or pith-balls, &c. Again, it is mainly the presence of resin on the musician's bow, that enables the performer upon certain stringed instruments, to produce the frictional electricity that calls forth into action the sounds he evokes. Mr. Rutter, of Brighton, showed, during particular experiments with his magnetoscope, that there was a polarity pervading all plants, and he demonstrated—as had been previously exhibited by Reichenbach—that this quality extends even to their seed, fruit and flowers. It has also been noted by enquirers into this subject that the one end of a tree or herb is negative and the other positive, as are the opposite extremities of their leaves. In fact, there would appear to be an escape of the electro-magnetic element, always taking place from the ends of the twigs and foliage of the vegetable world. This traversing fluid is of course supplied and interchanged by the ever-flowing electric currents pervading the earth. This economy explains why certain persons are oppressed when in a wood, and other individuals suffer even when standing near a single tree, which feeling ensues perhaps—as before noticed—from the parties in question being deprived of the usual quantity of the stimulating magnetism that traverses the deeper soil, and which instead of permeating their feet, is conveyed away by means of the roots up the trees. Again, the

* Urim signifies lights or explanations.

† The word Thummim means perfection and truth.

electricity of the air that should have passed through their persons into the earth, is conducted there by the taller trees. Many people in the same way became uncomfortable and cold when standing on asphalte, oilcloth, carpets, and even when they have woollen or silk stockings on, which sensations they do not experience when located on wood, stone, or the ground, these latter media do not isolate them from the magnetic currents of the earth. That we are always subjected to particular electro-magnetic influences, may be inferred from the development of peculiar feelings which at times pervade us, especially on what is called in England a balmy day, with the sky clear and purple and the wind warm and westerly, in which positive electricity prevails, and are unlike the breezes coming from the east, in which negative electricity predominates. Again, the influence of magnetic currents may be especially recognized by the fact that many *somnambules* have often been seen when very restless to get up in the night and place their beds so that their heads might lie towards the north; other sleepless persons have likewise arisen, not knowing the reason why—except from premonitory feelings—and arranged their couches in the same manner as the sleep-walkers, after which operation they could repose in comfort, as long as they continued to recline in this self elected position. Clairvoyants proclaim that we should always, when sleeping, lie with our head towards the north when we are on the northern side of the meridian, and to the south when residing on the other side of the equator. But to return. It may be demonstrated that there is a point in trees and plants which resembles the middle portion of a bar-magnet, and appears to be like the central or *nodal point*, through or from which differently qualified magnetic rays pass, the one set taking the opposite course to the other. Thus, it is after this mode that the roots proceed from a given locality downwards, whilst the stem and branches grow upward from the same point in the contrary direction. This economy holds good when we reverse the position of the tree,—that is, by placing the boughs or branches of young plants in the soil, inclining the roots upwards into the air, these latter will then be observed, instead of growing towards the sky, to tend downwards in the direction of the earth, the natural locality for the economy of the roots.

Further, touching the polar-magnetic disposition of the vegetable products, if we suspend, horizontally, in a still

atmosphere, as under glass shades, parsnips and carrots, or pears and apples, &c., by passing strings through them midway between the eye and stem of the one, and the base and apex of the other, they will be seen to arrange themselves diamagnetically or point east and west. It has been found possible to establish a vegetable electro-magnetic battery, by arranging a chain of pears or apples, &c., with the stem surfaces touching the eyes of those preceding them. The increase of magnetic intensity thus produced is readily detectible by the electrometer or magnetoscope and certain animal sensibilities.

Dr. Bacanio has shown that a few slices of beet-root and wood of the walnut tree, alternately placed, were capable of setting free sufficient electricity to excite convulsions in a frog, when conveyed to its muscles by means of a conductor consisting of a leaf of scurvy grass.

Baron Reichenbach in his experiments on vegetation, proved that plants *act magnetically*. Thus, he showed that the fibres of the root of a turnip were positive, but the tuber was negative below and positive above. He also found, that the temperature of a vegetable varied in different parts, manifesting an existence of *thermo-electric action*. Same plants proved to be warm on the stem, but the flowers were cool. Frequently the reverse of this prevailed. The Baron sums up his experiences, as follows : the root fibres are warm, therefore positive, the ends of the leaves were cold, consequently negative, the point of the stem loses itself in the leaves and leaf-buds, it, therefore, pervades the negative side. We may then of course state, that positive influence predominates in the descending axis, and negative in the ascending. Thus, *where nature is least busy, the growing activity is slackened and negativity predominates, but where propulsion shows itself positivity prevails*. Thus, the vascular bundles in the mid-ribs, and the under face of the lower part of the leaves towards the point of attachment, were always found to be positive, while the more parenchymatous (pithy) mass, the upper surface of the leaves, and the part towards the tip were constantly negative. That the ordinary processes of vegetable growth are attended with a manifestation of electricity, has most positively been proved by the experiments of Pavillet. Thus, several pots filled with earth, and containing different seeds, were placed on an insulated stand in a chamber, the air of which was kept dry by quick lime.

The stand was placed in connection with a condensing electrometer. During germination no electric disturbance was manifested; but the seeds had scarcely sprouted when signs of it became evident, and when the young plants were in a complete state of growth, they separated the gold leaves of the electrometer half-an-inch from each other. It was calculated by him that the vegetating surface of 100 metres square in extent, produces in a day more electricity than would be sufficient to charge the strongest battery, and he considers that the growth of plants may be one of the most constant and able sources of atmospheric electricity. The disengagement of vapour from the surface of leaves, is alone sufficient to produce abundance of electricity. Again, the gaseous changes which are effected by the leaves through their own economy upon the oxygen and carbonic acid of the atmosphere, may be regarded as other sources of its development. The condition of plants is usually *negative*, and from this fact Dr. Groves accounts for the violence of the meteorological phenomena in tropical climates. The evaporation taking place from the surface of the sea must tend, he states, to render the superincumbent atmosphere *positively* electrical, and that too, with the greatest intensity during the day, at the very time when the agency of terrestrial vegetation is rendering the air over the land *negatively* electrical. If a wire, says Dr. Carpenter, be placed in apposition with the bark of a growing plant, and another be passed into the pith, contrary electrical states are indicated, when they are applied to an electrometer. If platinum wires be passed into the extremities of fruits, they will also be found to present opposite conditions. In some fruits, as the apple or pear, the stalk is negative and the eye positive, whilst in such as the peach or apricot, a contrary state exists. If the prune be divided equatorially, and the juice be squeezed from its two halves into separate vessels, its portions will in like manner indicate opposite electric states, although no difference can be perceived in their chemical qualities.

(*a*.) Dr. Burdon Sanderson has lately made some important discoveries relative to the electricity of leaves, and the localization of the electricity to certain portions of them.

(*b*) There has recently been discovered in Nicaragua, Central America, a plant which has been named Phytolacea Electrica. It possesses very effective electro-magnetic properties. The hand is benumbed upon touching the shrub,

and the electric influence can be felt at a distance of several feet. The magnetic needle is sensibly pertubated, becoming more and more influenced until it reaches the centre of the shrub, when the disturbance is transformed into a gyratory movement. The intensity of the phenomenon varies with the hours of the day, and at night it is hardly perceptible. It attains its maximum of ability about 2 p.m. In stormy weather the energy of the action is augmented. No insects or birds have been seen on this tree.

(*c.*) Wood grows much more rapidly on the north side of a tree than the south.

(*d.*) The leaves of the polar plant of South America always point north and south, and serve to guide the traveller by land as the pole star does the sailor on the ocean.

(*e.*) Male plants are positive, whilst the female vegetation is negative.

(*f.*) Plants consist of closed sacs, having pouches and vesicles, and these latter are held together by vegetable mucus, and they are also polar, each pointing opposite ways, as does the plant itself, which extends, whilst growing, at both ends.

(*g.*) In speaking of the vegetable world, and the remarkable processes by which the leaf, flower, and fruit are produced, Kircher, upwards of two hundred years ago, brought forward the fact of the diamagnetic character of the plant, and he refers to the motion of the sunflower, the closing of the convolvuli, and the direction of the spiral (which in positive plants curls to the right, and in negative vegetation to the left) formed by twining plants, to this influence.

(*h.*) Crystallization is an electromagnetic phenomenon of inorganic matter, and the simplest rustic observer is struck by the resemblance which the examples of it, left upon the windows by frost, bear to vegetable forms. In some crystallizations the mimicry is beautiful and complete, as in the *Arbor Dianæ*, (*the tree of silver*)—this metal being called Diana by the old chemists) which is produced by putting metallic mercury into a solution of silver. This causes the separation of this latter metal into a beautiful tree-like crystalline form. Vegetable figures are also presented in some of the most ordinary appearances of the electric fluid. In the marks caused by *positive* electricity, which it leaves in its passage, we see the ramifications of a tree, as well as its individual leaves, those of the *negative*, recall the bulbous or spreading root, according as they are clumped or divergent. These phenomena seem to

point out that the electric energies have much to do in determining the *forms* of plants. That they are intimately connected with vegetable life is indubitable, for germination will not proceed in water charged with *negative* electricity, while this fluid *positively* loaded, greatly favours it. A garden increases in luxuriance when a number of conducting rods are made to terminate in branches over its beds. The resemblance of the ramifications of the branches and leaves of plants to the traces of the *positive* electricity, and that of the roots to the *negative* electricity, calls for special remark, as the atmosphere particularly in its lower strata, is generally charged positively, while the earth is always *negatively* electrical. The correspondence here is remarkable. A plant thus appears as a production formed on the bases of a natural electro-magnetic operation, for here the *electric brush* is realized.

ANIMAL ELECTRO-MAGNETISM.

309. This imponderable material element is common to all living creatures, it is spread out upon the membranous surfaces, and it also, like heat, enters into intimate combination with the ponderable atomized and perhaps the imponderable ultimate unparticled elements that constitute the frames and soft parts of all animals, whose nerves and structural fibres serve, like conducting wires, as it were, to convey this all-creative, and in turn, all destroying agent, that obeys some of the energies placed at the behest of nature's never-resting economics. Further, as the galvanic fluid can, in the laboratory, decompose compounds in solution, and the electric spark recombine them when separated, may not the *nervo-electric element* be found capable of acting after the same manner, on the compound fluids, and even living solids of the animal system? Is it not more than probable that the vital-magnetic fluid from the brain and ganglianic systems, as it traverses the nerves which branch off from them, decomposes the compounds conveyed through the circulation and by endosmose or infiltration to each organ? And further may not the sensorium and spinal cord, which are connected through the nervous fibrillæ, with every part of the body, act by means of their nervine aura, like the electric spark; and in this way unite the necessary elements, which the blood and other *media*

supply, so as to form or deposit the constituents that each organ may require to renew or replenish it, after the absorbents and other natural agents have removed the old, or, so to speak, used up parts or former components of the osseous system and visceral tissues?

310. "Is the brain," suggests Sir J. Herschel, "an electric pile, constantly in action? If so it may be conceived to discharge itself at regular intervals, when the tension of the electricity developed reaches a certain point, along the nerves which communicate with the heart, and there excite or cause the pulsations of that organ." This idea is intimated by the dry electric pile of De Luc, in which the successive accumulations are carried off by a suspended ball, which is kept, through the discharges, in a state of regular pulsation for any length of time, even for years.

That animal electricity is an agent in some of the processes of vitality, is shown in the following experiment. If the hind legs of a frog be placed upon a glass plate, and the crural nerve dissected out of one of them be made to communicate with the other, it will be found, upon making occasional contacts with the remaining crural nerve, that the limbs of the animal will be agitated at each contact.

311. The animal electro-magnetic element is most prominently demonstrated by certain electric fish, as the *Torpedo* (so called by the Romans from the effect it produced) or *electric ray*, and *gymnotus* (naked backed), *electrical eel*, and likewise the *silurus electricus*, described by Broussonnet, under the name of *trembler*. The electric fluid appertaining to these inhabitants of the water can decompose chemical compounds, produce an electrical spark, and magnetize iron by induction.

Humboldt states that the electrical eel is most frequently met with in the stagnant ponds, situated in the plains which extend from the Oronoco to the Apure. The old road near Urutica has been abandoned, on account of the danger experienced in crossing the ford, where the mules were, from the effects of the shocks given by these eels, often paralysed and drowned. Even the angler sometimes received a shock conveyed along his rod and line. These animals are about 6ft. in length, and occasion a highly painful sensation, more resembling the effect of a blow on the *head* than the shock of a common electrical discharge. The Indians have a great dread of the gymnotus. Humboldt, wishing to obtain some of these eels, solicited the natives to procure a few for him. In

order to effect this object, a number of Indians collected about thirty horses and mules from the adjacent savannahs, where they run half wild; these animals were driven into the marsh, and the *gymnoti*, roused from their repose by the noise and tumult, mounted near the surface, and swimming like so many livid water serpents, briskly pursued the intruders, and gliding under their bellies, discharged through them the most violent and repeated shocks. The horses became convulsed and terrified, their manes erect, and eyes staring with pain and anguish, and made unavailing struggles to escape. In less than five minutes, Humboldt states, two of them sunk under the water and were drowned. After a time the *gymnoti* finally retired from the contest, and such was the state of languor and complete exhaustion, that they were easily dragged on shore by the help of small harpoons fastened to cords.

The gymnotus experimented with by Faraday, gave a strong shock when one hand was placed near each extremity of the fish. By the application of conductors the animal affected the galvanometer, and also made a magnet. Polar decomposition of iodide of potassium, was easily effected by it, with such phenomena as indicated a current passing from the anterior to the posterior parts of the animal, and, lastly, the electric spark was obtained.

The *sepia hexapodia*, or six-legged cuttle fish, can produce a numbness when handled. There is fresh water fish belonging to the family of siluroids (silurus, a sheath fish), which possesses an electric organ. This animal has been named the *malapterurus Beniensis*, so called from having been found in the river Beni of West Africa; it is allied to the *malapterurus electricus* which inhabits the Nile, and was known and used in long ages past for its electrifying abilities to cure the sick.

"Man" says Dr. G. Bird "far exceeds the torpedo in generating electricity, and is only prevented from giving a benumbing shock, when he extends his hand to greet his neighbour, from the absence of a special electric organ for increasing the tension or intensity of his electro-magnetic fluid. The formation and decomposition of the different gases, fluids and solids of the body must be an immense source of animal electricity, for it is impossible that any two elements can be united and especially separated from each other, without setting free a current of electricity. Faraday has, by his experiments, rendered it probable that, during the decomposition of 9 grains of water, an amount of electricity is developed, far greater in quantity

than that which is called into action during the production of the vivid lighting flashes and thunder explosion of the dread inspiring tempest." "May not," continues Doctor B., "one of the uses of the electricity so freely developed in the body, especially that existing in the muscles, be to call forth in the nervous cords the *vis nervosa* (that ability of the muscles by which they act when excited by the nerves) just as currents of electricity, if passing near a bar of iron at right angles to its axis, excite magnetism? May not this *vis nervosa* or nerve energy, produce the contraction of a muscle without actual contact with its fibres (for we know that the fibrillæ of nerves lie upon, but do not communicate with the ultimate filaments of a muscle) just as the invisible lines of energy emanating from the bar-magnet act upon the suspended bundles of wire or fine iron filings? Lastly, may not such nervous ability again induce electric currents in glandular or other organs, just as magnetism in motion will re-excite electricity, thus accounting for what cannot be questioned, the existence of electric currents in certain organs, exclusively excited by or depending for their existence upon the integrity of the nervous influence of the part."

Professor Aldini proved that the muscular contractions are excited by the development of an electric fluid in the animal system, which is conducted by the nerves to the muscles, without the concurrence or action of metals. In proof of this statement Aldini procured the head of a recently killed ox. With one hand he held the denuded legs of a frog, so that the portion of the spine—still connected with the lumber nerves—touched the tip of the tongue of the ox. The current was completed by grasping with the other hand—well moistened with water—one of the ears. The legs of the reptile in question instantly contracted, the spasm ceasing directly the circuit was broken by removing the fingers from the held ear. The intensity of these contractions was much increased by *uniting two or three heads*, so as to form a kind of battery, just as Mattencie found to be the result 40 years afterwards with his pigeon and rabbit battery.

312. With the exception of the stomach and cæcum (the first portion of the large bowel) the whole of the lining membrane of the alimentary canal is bathed with an *alkaline* mucous fluid, and the external covering of the body, the skin, is constantly exhaling an *acid* fluid, except in the axillary, and perhaps pubic or genetal regions. The mass of the animal frame is thus placed between two great envelopes, the one

alkaline and the other acid, meeting only at the mouth, nose, eyes, and anus, or termination of the bowels. This arrangement has been shown by Donne to be quite competent to the evolution of a large quantity of electricity; and he found that if a platinum plate, connected with the galvanometer, be held in the mouth, whilst another of the same metal is pressed against the moist perspiring surface of the body, the magnetic needle will instantly traverse, just as when experimenting with an acid and alkali in vessels. Further, a singular energetic current can be detected when the platinum plates are plunged, the one into the acid contents of the stomach of the animal, and the other into the alkaline secretion of the liver. Dr. Baxter states that whenever a platinum plate, connected with a galvanometer, is placed in contact with the mucous membrane of any part of the alimentary canal, and another immersed in the blood escaping from a wounded vessel, an electric current can always be detected. It appears as if the secreted matters were ever in an opposite electric state to the blood or other *media* whence they are generated. These electric currents cease on the death of the animal. Dr. Woolaston suggests that the secretions of the body are the effects of electrical agency acting in various modes, and that the qualities of each secretion point out what species of electricity preponderates in the organ which creates or forms it. Thus the existence of free acid in the urine, and gastric juice, and of free alkali in the bile and saliva of the mouth, marks the prevalence of *positive* electricity in the kidneys and stomach, while an excess of *negative* fluid is indicated in the liver and salivary glands.

313. Dr. W. Phillip proved that when the pneumogastric nerve, presiding over the lungs and stomach, and consequently the economy of respiration and digestion, was divided, in a rabbit that had just partaken of a hearty meal, the food remained in the stomach unaltered, but on allowing an electric current to traverse the nerves by connecting their divided ends through means of a metallic conductor or by apposition, digestion was readily effected.

314. *Touching the electric action of the fluid transmitted by the nerves.*—A balanced magnet held between the two sections of a recently divided nerve was observed to be deflected as if subjected to the influence of an electric current. The muscles under the sway of the nervo-magnetic element are capable of energetic contraction as when stimulated by the galvanic fluid. Clairvoyants announce that there are electro-magnetic streams

always flowing along the nerves to each organ of the body and every tissue of the system. Further, they also state that the human body is made up of many magnets, all governed by the great positive brain, which under the influence of the soul, presides over all our functional systems. They likewise proclaim that the right side of the body is *positive* in regard to the left, which economy gives rise to the preference in the use of the right arm and leg. The *superior* parts of the body, they say, and even that of the limbs and the individual bones and muscles, &c., are positive, whilst relatively the *inferior* ends of these structures are negative to the former, like the poles of a magnet. Again, one organ of the body acts *positively* as regards another viscus. Thus, the alkaline secerning liver is *negative* whilst the acid secreting stomach is sympathetically *positive* to it. The right kidney, testis, and ovarium (egg-pouch) are positive as regards their left associates. And lastly, the great *positive* cerebrum presides over the pulsations of the *negatively* answering heart, as does the cerebellum (small brain) over the functions of the *negative* organs of generation.

315. According to Faraday's established doctrine of electro-chemical equivalents, all chemical changes are the result of electric action; therefore it is most probable, nay, a fact, that the brain and spinal marrow include organs able to collect, and through the nerves use this electricity, which, modified in its effects by the properties of life, is the immediate agent of the assimilating functions, and so is the nervous system of animals capable of gathering and applying, even according to the dictates of the *will*, the electric capacity which is evident from the phenomena of electric animals.

316. Vital animal electricity, as before noticed, is an agent possessed by and evolved from certain living animals; which enables them, independently of the operation of external agents on their structure, to produce several of the phenomena exhibited by common and voltaic electricity, generated in and upon inorganic matter. This electric ability is even possessed by certain insects, as the *reduvius serratus*, which gives a shock when placed on the hand felt up to the shoulders. There is also a species of *mantis*, a native of Brazil, which on being touched causes a shock perceived through the whole body.

316. Further particulars relative to the economy of the torpedo. The electric discharges from this animal, both with regard to time and intensity, seem to be dependent on the exertion of the will quality. It has been demonstrated that

this creature can eject electricity both in air and water. The *intensity* of the electric ability seems to bear no relation to the size of the fish after it has attained mature age. The animal becomes exhausted subsequently to the discharges, and recovers its capability by rest. The fætus can give strong shocks, on being taken out of the parent. The torpedo when removed from the water, can give more violent shocks in the air, than in its native element, and can discharge its electricity in any direction. The shock is most effective, when one hand is applied to the head and the other to the tail. Metals cause it to discharge the fluid as often as it is touched by them. The animal can kill a fish or water-bird without touching them. To receive an efficient charge, both sides of the animal must be simultaneously grasped, and the creature, when it gives a shock to anything, tries to do the same, by encircling the object presented to it. Some eels are said to be twenty feet long, and can deprive a man of sense and motion. One of these fish has been known to give twenty-seven people a shock at the same period. At times the discharge only occasions strong contractions of the flexor muscles of the hand that clasps the fish. Some men are *unsusceptible* of feeling the discharge from electric fish as others are from that of the *Leyden jar*. Women, it is said, with severe nervous diseases, are seldom conscious of receiving the shock. The artificial and natural *somnambules* scarcely notice the heaviest discharges from the Leyden phial, and are found to bear the strongest current from the galvanic battery, and the electro-magnet machine, without being disturbed. My own *clairvoyants* could see the electric currents passing through their bodies, but could not *feel* the presence of the fluid that was permeating their systems, nor were they capable of recognising heat, though touched with an incandescent body or when exposed to the flame of burning materials, or subjected to the operator's knife, patients in the sleep-waking state suffer no pains during parturition, like as when under the influence of chloroform. But to return. Galvani perceived that the frogs thighs were always convulsed when he touched them whilst grasping the *torpedo*. Schilling asserts that the magnetic needle can be set in motion by the fluid from the *gymnotus*, also that this fish was attracted by a loadstone, and adhered to it, and that the animal became languid when detached from a magnet, it was also found capable of giving the spark when irritated. Dr. Davy converted needles—

previously free from any electrical quality—into magnets by contact with the *torpedo*. It was also found that the ends of the needles which were nearest the central surface of the fish received southern polarity, the other ends being north. The fætus when removed from the parent produced the same results. All bodies which will conduct electricity can convey the magnetic fluid of these animals. The French fishermen say they often feel the discharge along the nets, and that the fish in question can give a shock at some distance through the water. Professor Owen states that the *torpedo* can electrify people in the act of throwing buckets of water over them. Here the electric current passes from the dorsal surface of the batteries against the stream to the operators hands, and the circle is completed by the earth from the men's feet to the central surface of the fish. Hunter states, that if you cut through all the nerves of the torpedo passing from the brain to the electrical apparatus—which was very vascular—no shock was given. He also noticed that each nervous column was divided into numerous distinct compartments by delicate membranous partitions, placed horizontally at very short distances from each other. The electrical organs have a great supply of nerves, and also a number of nervous glandular ganglia surrounding them, from which pass a vast quantity of ducts opening on the back, forming a communication between the electrical organs; these are apparently better conductors of electricity than the bare skin or salt water. The electric apparatus of the *gymnotus* is also arranged between *septa* or partitions. Hunter counted 240 in the space of an inch, and these answer the columns in the torpedo. Lacepide calculated that the discharging surface of these organs in a gymnotus four feet in length, is at least 123 square feet in extent, whilst in the torpedo of ordinary size, the discharging surface was only 58 square feet. The nerves in the former fish supplying the electric organ are from the spinal cord alone.

The electrical organs of these animals develope and evolve electricity under the nervous influence, just as a gland may secrete its particular fluid, and its ducts eject it. When two persons (especially of opposite sexes), both insulated, join hands sufficient electricity is evolved to affect Colomb's electroscope. If a lady when brushing her hair, whilst standing on a stool supported by glass legs, was to place the fingers of the disengaged hand upon the cap of an electrometer, the gold leaves would be seen instantly to diverge with great energy, at each

frictional movement of the brush, thus giving evidence of animal electricity.

Again animal electro-magnetism is evolved by the mere contact of two dissimilar animal substances. Thus, a pile of alternate slices of muscular tissue and brain, with pieces of wet leather interposed, has been observed by Lagrave to produce electricity. When the muscles of the great nerves of a frog's leg are touched synchronously with a piece of muscle of a warm-blooded animal, contractions of the reptile's muscles ensue. Further, when the crural muscles are cut and folded back, so as to touch the lumber nerves, muscular contractions are perceived in the lower part of the limb. Aldini excited energetic contractions by bringing the nerves of warm-blooded animals in contact with the muscles of cold-blooded creatures, and *vice versa*. Müller found that contractions are excited by touching the moistened skin of the leg, with the nerves of the thigh dissected out and turned down upon them, the nerves being held by means of an insulating rod.

317. Hemmer, of Menheim, 1786, obtained the following results. (*a*) Electricity is developed in all persons, but varies both as to intensity and character in different individuals. (*b*) The nature and vehemence of the electricity varies in the same person. (*c*) When the body is at rest and warm, its electricity is always positive. (*d*) When the surface is much cooled, the electrity becomes negative. (*e*) It is constantly negative when muscular viguor is diminished. M. Ahrens has more recently proved that, (*a*) The electricity of healthy men is generally positive. (*b*) Irritable men of sanguine temperament have more free electricity than those of the phlegmatic disposition. (*c*) An increased accumulation of electricity takes place in the evening. (*d*) Moderate portions of spiritous drinks augment its intensity. (*e*) The electricity of women is more frequently negative than that of men. (*f*) In winter when the body is very cold, no electricity is manifested, but gradually reappears as the body becomes warm. (*g*) Every part of the naked body shows the same phenomena. (*h*) During the existence of rheumatism, the electricity is greatly diminished in intensity, but as the disease declines it again increases. Gardini found that the electricity of women during the menses and pregnancy is negative.

318. Some individuals exhibit electrical phenomena more readily than others. For instance, various persons hardly ever pull off articles of dress, worn next the skin, without a crack-

ling noise being produced. Others always throw off sparks when the hair is stroked backwards. We read of an Italian lady who continually gave out electrical flashes when her skin was rubbed with a linen cloth, attended with a crepitant sound. This occurrence takes place when the feline tribe and other animals having soft fur are quickly stroked. Romer and others, relate that if you take a cat, in dry weather, into the lap, and apply the left hand to the breast, while with the right you rub its back, at first a few sparks are obtained from the hair, but after continuing the friction for some time, a shock is received, which is often felt above the wrists and forearms. At the same time the animal runs off with an expression of terror, and will seldom submit itself to a second experiment.

Dr. Carpenter mentions a lady who could pass four electric sparks every minute into the brass ball of the stove, at a distance of $1\frac{1}{2}$-inches.

This occurrence took place whether dressed or unclothed. There was a family, reported by Bleumenbach, each member of which could elicit the same phenomena, and they were called the electrical family. Horses, like the one belonging to Tiberius of Rhodes, sometimes throw off sparks when rubbed, perceptible in the dark. Again, many persons similar to Theodorus, eject electric flashes on taking off their clothes, as was the case with Dr. Thompson, who could exhibit this result, on taking off his silk stockings in a darkened room. Humboldt states that upon the high table-lands of Mexico, where the atmosphere at times is very dry, the horses manes become luminous, and emit a crackling noise, as also do the outstretched fingers of the human hand in some individuals. These phenomenal lights ejected by certain individuals, according to Professor Daniel, used formerly to be regarded with feelings of dread by superstitious people, and in Italy went by the name of the fire of St. Elmo.

319. People in general doubt the existence of the animal magnetic fluid appertaining to the human subject, and especially are they sceptical as to the capability of this element being ejected from one person on or into another. They fail in like manner to imagine, and especially to comprehend, how this principle could possibly be transmitted without contact. Further, from incapacity to perceive any phenomena themselves; individuals assume that they do not exist, forgetting that that which is recognisable to the sensitive faculties of one fellow creature, may make no *conscious*

impression upon another. We should never presume to decide or even think that an action or element does not exist, because its being—during certain conditions—is imperceptible by or hidden personally from us. For example, we cannot see pure air nor feel its presence, though exerting a pressure of many tons upon our bodies, and if it were always tranquil, we should not be aware of its entity, and especially should we be ignorant of its capable operative effects, when aroused by the *imponderable* elements into energetic action.

By influencing a piece of iron we, through a certain process, form it into a magnet, by either altering the arrangement of its atoms, or the reactive ability of the principles which surround them, but whatever the change, the needle so acted upon, has become a magnet, yet it has undergone no alteration our senses can comprehend, it has acquired no weight which can be detected by our mental efforts. Yet, solely because we are sure that we behold, after a certain manipulation, distinct phenomena, we allow that there is a particular form of electricity to which has been given the name of magnetism. Why should we refuse to the mesmeric fluid body, enquires the Rev. Mr. Townshend, that capability or capacity we have granted to the magnetic principle which pervades the iron?

There are many *media* in nature and the finer or unparticled ethers may and do occupy the interstices of the grosser, being distinct, yet interposed, one within the other. The atmosphere is the medium through which the *spiritous matter*, sound, is conveyed to us; at least a bell rung under the exhausted receiver of an air-pump is inaudible. But the crystal wall that keeps out air and common electricity bars not the passage of light, heat, and magnetism. Electricity can only traverse certain bodies, but undulatory mineral magnetism, like that ejected from animals, can penetrate them all, yet its intensity is vastly inferior to ordinary electricity. It has been recognised that the attractive and repelling rays from a magnet are only capable *perceptibly* of influencing inanimate bodies when at a given distance, yet the animal magnetic fluid has been known to sensibly affect beings at almost any distance.

320. *Nervous or animal magnetic fluid.*—Some mesmerisers have been known to be capable of giving shocks to their patients, without contact, like the electric fish. I myself could produce this effect, especially when standing at a distance behind the back of a Miss Whiting, an elderly corpulent patient of mine. Dr. Whitfield states, in his letter

to Dr. Eliotson, "that he found the magnetic fluid passed the most direct way, so that if the feet were held by the hands of the operator, the legs being thus magnetised would become warm, and the head cool. If the mesmeriser, or rather magnetiser grasped one hand, likewise the corresponding shoulder, the principal effect would be confined to that side. I inferred from this, by analogy," repeats the Doctor, "the possibility of producing a magnetic shock, and I have repeatedly taken a hand in each of mine, and by relaxing the will-influence for a time and then pressing the hands, seen the arms of the patient convulsed with the sensation as if an electric shock had passed from the chest. The phenomena were even more remarkable if the left hand and right foot were clasped, as then the shock was sufficiently strong to throw the opposite arm from the side. If the fingers be *separated*, the sensation of the animal electric aura will be communicated from each finger." "I am acquainted," continues Dr. W., "with six individuals of both sexes, who are capable of imparting shocks, and these can by mental energy be made more effective than the subjects of them are willing to bear."

321. *Animal magnetic attraction.*—Some individuals when in the mesmeric sleep, cannot allow the magnetiser to leave them, they lean towards the operator as if he were a part of their existence or a second self as the Greeks termed it. A gentleman in the sleep once asked if the hand he held was his own or that of his mesmeriser (the Rev. Mr. Townshend), for he could not distinguish the one from the other. Dr. Whitfield in his remarks on this subject observes, "I have contrived by means of a metallic chain or long piece of wood, to stand many feet from the patients, they holding one end and I the other, but they were instantly conscious if I relaxed the *firm grasp* of the chain or ligneous rod." "I find wood," continues the Doctor, "to be a good conductor of nervous fluid as it is of sound." This explains why Dr. Haygarth's wood "tractors" answered as a curative means as well as Mr. Perkins' metallic "tractors," the remedy not being in the apparatus employed, but in the hand that held them.

322. *Effects of magnetic will-ability or soul energy.*—The Rev. Mr. Townshend (p 381) relates the case of a lady who was unable, from paralysis, to stir a limb, but she could in the mesmeric sleep condition, and also in her natural somnambulic state—into which she sometimes spontaneously fell—actively use all her members, as when she was in perfect health. The

transition from a state of active exertion to one of passive helplessness was very remarkable, and often alarming, since if her natural magnetic fluid became dissipated she would suddenly fall. The parallels to this may be found in paralytic patients, who sometimes have recovered the use of their limbs for a short time, when they were incited to save themselves from fire or other threatening evils; but the provocative being withdrawn they have fallen helplessly to the earth; even persons who have been dumb for years have spoken under circumstances where strong emotion burst their bonds of speech. Nor are these the only cases to which magnetic sensations bear analogy. For instance, some partially paralysed persons can often effect their purpose, by increasing—through their *mental volition* or *will-ability*—the magnetic nervous fluid, but the moment they cease to do this, they can no longer accomplish their object. Dr. Carpenter relates the case of a woman, who, while she stedfastly contemplated her infant, could hold it very well, but the instant she left off regarding the child, she let it fall. I myself had a patient, the Rev. Mr. Hennage, of the Good Shepherd, Hammersmith, who was the subject of incipient paralysis; he could stand or walk, whilst *intently* regarding his legs, as they supported his body, but he instantly fell to the ground if any circumstance or feeling interrupted his attention or prevented him from employing the necessary amount of magnetic energy.

People under delirium, the natural somnambule, and persons in a like state to the latter through mesmeric manipulations, are known to be capable—by using with greater energy their nervo-magnetic fluid—of lifting or removing enormous weights in comparison with those they could accomplish in the common or natural state. This result images the able contractile condition of the muscles under the influence of the galvanic current.

323. *Animal magnetic attraction.*—The electric fishes can attract each other and influence the magnet, and in turn be biased by it, so the mesmeriser can draw and sway his patients, like the loadstone acting on the iron. Thus, the Rev. Mr. Townshend relates (p. 160) that he could attract the head of a gentleman, when sleeping, which ever way he pleased. If he held his hand above the patient's leg, immediately the limb was drawn upwards, until it formed an acute angle with the body, as did the hand and arm, when acted upon. Finally when Mr. T. left the room, the sleeper

was obliged to follow him. The hands of another gentleman could be influenced in the same way, through a screen. All these effects were also produced by the mesmeriser's foot and even with his head. "Again," continues Mr. T., "when standing opposite one of my patients, who was in an upright position, I began to turn round, she also seemed forced to revolve, but in a direction contrary to mine. If I turned from left to right, she revolved from right to left, and *vice versa*. I tried the same experiments," observes Mr. T., "on other sleep-wakers, they also turned round when I did, and inversely to myself; but my foot, when presented to them, instead of making them revolve, seemed simply to repel them. I tried this with the sister of Theodore. Every time I held out my hand she was attracted towards me, whenever I presented my foot, she was repelled, and by the alternate exercise of these two influences, she was kept oscillating to and fro, like the pendulum of a clock." I myself have produced similar effects both upon men and women, I have also seen the same concurrences by the brains' nervous energy exercised by a mesmeriser when at a distance, as performed by Major Buckley, Mr. Thompson, and Dr. Ashburner. As regards my own *will-energies* in effecting these results, I, like Dr. Elliotson, had no influence over my patients. (See my work on "Will-ability.")

324. *Action of the magnet on sleep-wakers.*—Desirous to try if the different poles of the magnet," continues Mr. Townshend, "would produce dissimilar effects, I held the south pole to the forehead of one of my patients, when she made sundry oscillations with her head, which at length slowly advanced towards the magnet. On presenting the north pole her head began to retreat, gently, and with an unsteady motion, like that of the magnetic needle. Sometimes when I have presented the north pole, the patient's head has retreated by jerks, as if driven backwards by successive shocks. The south pole, on the contrary always exerted an attractive ability over mesmeric sleep-wakers. They dislike to be submitted to metallic magnetism, because it produces in them disagreeable sensations. "I once asked," says Mr. T., "a patient whether there was any analogy between animal and metallic magnetism, the reply was, there is a similarity, but the latter is of a much coarser nature."

According to Baron Reichenbach (p. 120) when a glass of water is placed between the poles of a horse-shoe magnet—consequently in the magnetic current—it becomes magnetised, and

every sensitive patient can not only at once distinguish it from common water, but the glass brought immediately after the magnetization to the hand of a cataleptic (trance like state) patient attracts it like a magnet. Something must therefore have been projected from the magnet into the water, as it would into a piece of iron. Again, the Baron made passes with a magnet over one of his visitors, who, to the great surprise of those present could then attract the limbs of the patients, and this ability remained for some time, and then by degrees disappeared. Here the magnetic fluid—as with the iron and the glass of water, must have been conveyed into or upon the said visitor, which was made manifest by his being able to call forth the same results, as could the Baron when applying, by means of the fingers, his own innate nervo-animal magnetism.

325. *Nervo-animal magnetism associated with electricity.*—The Rev. Mr. Townshend sometimes formed, what might be called a mesmeric pile, by seating five or six persons together in a line or half circle, holding each other's hands. Having magnetised the first in the rank, the influence was passed on to the second, who transmitted it to the third, and so on, by each pressing, at regular intervals, the hand held by the other.

Here the mesmeric influence was most demonstrated in the person farthest from myself. The first individual scarcely felt any sensation, the second being affected more, and so on in progression, until the last was thrown into the nervo-magnetic sleep.

326. *Friction increasing the magnetic ability.*—If the mesmeriser, whilst manipulating his patient, rubs his head with the disengaged hand, his nervo-magnetic energy becomes greatly enhanced.

327. When a mesmeriser or rubber—as before stated—manipulates an exhausted patient, the operator sometimes becomes rapidly weakened and depressed, showing that he lost and of course imbibed (action and re-action always being equal) *something*, which robbed him of strength at the same time, giving energy and finally health to the individual he was magnetising. The mesmeriser has often rekindled life and as it were *attracted* back the departing spirit, enabling it to still inhabit the body thus cleared from disease by the magnetisers efforts and will-energy. This result is more readily effected in certain conditions of the surroundings. Thus, when electricity abounds in the earth and air, we are in a *negative* state, and

become depressed, but when magnetism is in the ascendant, then we are *positive*, and disposed to activity, joy and friendship.

328. Some of the feathered tribe are readily animally magnetised; for instance, if we place a turkey or common fowl on a table or plank—holding it down for a few seconds—and then draw a straight line with a piece of chalk, from the beak over its head and bill for some way along the board on which it rests, the bird so treated will become fixed to the locality for any time we please. The same result follows if we use the bare fingers, unarmed by the calcarious substances, especially when executed by certain persons. Again, if we place the head of one of these creatures or any other of the feathered tribe, under its wing, and whirl the animal round, whilst in the hands for a short time, and then lay it on the ground, the bird will sleep, where placed, for hours together. Many persons by exercising their will—aura or ability alone—can command animals as Van Amburg, Carter and Rary did. I have seen Major Buckley when in the Zoological Gardens, send some of the great birds, by the souls energy or magnetic aura (acting through the eyes), into the charmed sleep. I have also witnessed other persons electro-biologise dogs, cats, and even the lion into a profound sleep, lasting for hours. (See my work on "Will-ability.")

329. It has been said that the sleep induced by animal magnetism is as distinct from the common or natural repose, as is the apoplectic stupor from refreshing slumber.—*Medical Review*.

330. *As regards the results of animal electro-magnetism.*—Clairvoyance is sometimes a sequence resulting from nervo-cerebral influence. I have always found that the subject so endowed—whilst exercising the soul's ability freed from its bodily *educational shackles*—will only respect and appreciate knowledge, goodness, affection, wisdom, and educated genius; they always esteem things for what they are usefully or naturally, worth; showing that titles, earthly honours and professional distinctions are not recognised among the aspirings of the unbound soul. The clairvoyant-sleep-waker can readily perceive and fully appreciate truth, benevolence, and the sacred love of pure and simple friendship. It has been asserted by sceptics that when the attention of a patient is pre-occupied or diverted from the mesmeriser's processes, or the mind has not been previously advised as to the effects that

are to follow the magnetic operations, the agency is null. That this is not the fact can be demonstrated, by nervo-mesmeric results being produced where the persons acted upon were at a distance, and also when they could not possibly have known what was transpiring. Again, it has often occurred that whilst the mesmeriser was manipulating an individual upon whom no effect was produced—another person in the next room, unconscious of what was going on, passes into the magnetic sleep. Further, where the manipulator and the patient are both *positive* or both negative to each other, there can be no sympathy and consequently no attractive re-action, and of course the individual magnetised cannot be impressed. Be it also noticed, that the person under manipulation. and he that manipulates should be very composed and quiescent, like the object we intend to ignite with a burning glass, the substance must be kept still or no effect can be produced. Again, as to the state of mind during the process in question, a person when angry or cross—though it be but a child—cannot be tickled into laughter, nor could an individual in such a mood, produce magnetic effects, for here the superior influence of the soul supersedes or is withdrawn from the magnetic influence.

331. *As regards the difference in persons presented for manipulation.*—We may have a repugnance to a certain individual and feel indifference as regards another, and be possessed of a leaning or attraction towards a third, and it is this latter that we can produce magnetic effects upon. Be it also noticed, that some persons cannot be influenced, so as to produce any recognizable results. But the magnet fails to control wood after the manner it does iron, yet it acts on the ligneous substance, though the consequences vary, because the *qualities* of the two bodies are dissimilar, and so it is with the *properties* appertaining to the constituents and nervous system of different individuals.

332. *Parallels to the magnetic sleep.*—1st, The Trance. The celebrated Colonel Townshend could pass into this state whenever he pleased. The Dervishes or Fakirs, were in all ages known to accomplish this feat. See the case reported by Captain Wade, who witnessed with many others the disinterment of a Fakir alive after having been buried in a recent vault which had been covered with earth for ten months, and over which had been sowed and reaped a crop of corn. I myself knew a Mr. Joyner of Berkeley, who saved his aunt from being interred. The lady was in her coffin, but knew all that

was transpiring, even to hearing the bell ring out for her funeral; but it so happened that whilst her nephew was looking at the hand—she succeeded—aided by his touch, in moving the finger, which subsequently led to her removal from the coffin, followed afterwards by resuscitation. Miss Joyner lived many years after this occurrence. It should be here mentioned that thousands of individuals are yearly buried alive, for we have no positive test for death, save through the nose, when decomposition has set in. 2nd, The magicians, soothsayers and witches of olden times, by narcotics and other means produced a cataleptic state of body resembling death, from which when partially waking their prophetic faculties were exercised. 3rd, Chloroform produces a senseless sleep. In all these cases clairvoyance was often induced, which now and then ensues under the use of chloroform and the employment of nitrous oxid or laughing gas.

333. *Attraction and repulsion.*—It is a well-known fact that certain persons, especially clairvoyants, are capable of distinguishing—whilst in a darkened room—definite luminous *gyratory* rays or undulations bursting particularly from the two extremities of the common magnet. It has also been demonstrated that these phosphorescent magnetic rays turn spirally themselves, like revolving corkscrews. This quality appertaining to these *polar waves*, explains why the north and south ends of magnets glide or are attracted towards each other when approximated. The magnetic pulsatory threads escaping from the dissimilar extremities of a loadstone revolve contrary ways, viz.: one turning to the right, and the other to the left. Thus, when the escaping spirally rotating threadlike rays meet, they wind one within the other, and of course the diverse ends of the magnets approximate each other. The opposite action to this ensues, when two negative or two positive poles approach each other: then the corkscrew-like undulatory threads are found to be reversed, and they move or turn in an opposite direction to the above, and now the similar poles retreat from each other. These different results ensue after the manner of a screw-pin, playing in its properly fitting nut or mother as it is sometimes termed, which accordingly as they are turned, recede from or approach each other.

The quantity and reception of undulatory waves thrown off from bodies, is the same (of course varied according to the *magnitude* and *quality* of the masses of matter from whence

they emanate) whether these substances lie close together or are millions of miles apart; but not so the *intensity* of the pulsatory rays; their energy increases in the ratio of the approximation of one body towards the other.

334. *Relative to the employment of Animal Magnetism.*—This process is a dangerous application, when used by persons ignorant of the mode of managing its results. The practitioner of this art must be very particular to always protect the patient from the touch, and sometimes from the very *presence* of certain persons. I have known clavic or convulsive spasms, lasting for many hours, ensue from the mere contact of the hand of a third person, others could not be awakened out of their sleep for many hours, after a visitor had made passes over the patient, and when the persons did awake they were sometimes found to be in an idiotic state for some days, or as if deranged. Various other evil consequences have followed from want of knowledge as to the proper mode of procedure when entering upon the practice of curing the sick by animal magnetism. For instance, I once saw a lady who was in what has been called the *mesmeric dream*, where persons appear, from their acts, to be in the presence of distant individuals and objects. Sometimes dancing with the most profound and graceful movements as if on the stage in a ballet, at other times like one of the almeh gesticulating before an Eastern emperor. During some periods they would appear as if leaning joyously and caressingly over a sleeping infant, and then would come a change over the spirit of the dreamer, who with woe begone face would seem to be now picking imaginary flowers, and then bending downwards, commence arranging them, as if over some dead *friend*. It was whilst under a like influence that the lady in question was touched by a visitor, after which she instantly fell to the ground as if shot; the pulse and breathing ceased for a long time and we all concluded she was dead. Fortunately there was a sleeping clairvoyant present (Ellen Dawson) who solicited the mesmeriser, if he wished to save the lady's life, to place his left hand, with a piece of silver that was in his pocket, on the head of the patient, and then make upward passes with the right. The lady under this process, after a time, suddenly heaved a deep sigh, then resumed her breathing, followed by a return of the heart's action, and happily after some hours the patient recovered. Children are not allowed to play with combustibles or appliances that may prove injurious when erroneously made

use of, nor should inexperienced people venture upon the use of remedies whose effects they are unacquainted with. Persons often naturally pass into strange states, which from erroneous treatment by the doctor or other officious individuals terminate in permanent idiotcy or madness. Now as these states, both recent and chronic, have been many times cured through mesmerism, so they might have been prevented by the early application of this remedy.

335. *Vital animal electro-magnetism as a therapeutic agent.*—Animal and mineral magnetism is the most ancient and successful healing agent for the sick on record, and has been employed more or less in every age and clime, as a means to cure the unhealthy.

(*a.*) The application of the torpedo was employed in bygone ages for the cure of *headache* and gout, and highly recommended by Scribonius Largus, a physician in the time of the Emperor Tiberius. Pliny mentions the electricity of this fish as a valuable therapeutic agent, and Diascorides has recorded a case of *prolapsus ani* (protrusion of bowel) that was cured by it.

(*b.*) The Arabian physicians employed electric fish to give shocks to their patients. In the same way the negresses in various parts of Africa, have for thousands of years been accustomed to place weak and sickly children in the pools of water containing electric fish, in order to effect their cure.

(*c.*) The priests of Brahma, in the earliest periods of the world's history, practised in India this mental and manipulatory science, whereby they were said to heal the spirit and cure the body.

The Chaldean priesthood, in some of the most distant eras, removed diseases by the imposition of the hands. Indubitable vestiges of this practice are likewise found among the *monumental* records of India and Egypt, where the priests are represented laying their hands on the sick. Further, it would appear from certain ancient written memorials that the time-honoured Magi of the Eastern world, produced the *temple sleep* by animal electro-magnetism in the fanes or sanctuaries of Isis, Serapis, and other medical deities. Zoroaster states that the Parsees in Asia, like the Egyptian sacerdotes in their sacred mysteries, possessed a knowledge of this magnetic science or ability. The Greeks derived their cognizance of vital animal electro-magnetism from the Indian and Arabian sages, and in turn communicated their knowledge of this subject to the Romans.

(*d.*) Dr. Mesmer, of Merseburg, in Swabia, one of the most learned physicians of his day, the friend and contemporary of Hahnemann, Humboldt, Lavater, Gall, and Goëthe, received his first impetus of animal electro-magnetism from Father Hehl at Vienna.

(*e.*) The doctrine of therapeutic human electricity has been most sedulously cultivated among the learned and enterprising, and also by those possessed of moral courage, and who are capable of thinking and acting for themselves, throughout every part of the globe. It has likewise been most carefully preserved in every age, although occasionally obscured by false notions, prejudices, and misconceptions, in regard to its true nature and legitimate objects. In this more enlightened age let it be our endeavour to hand it down to posterity in its most noble, pure, and beneficial form.

(*f.*) *Psychomancy*, otherwise the treatment of the sick by the soul through the hand. This therapeutic practice of the laying on of hands was exercised by the ancients after various modes. Thus a direct sanative efficacy was ascribed, by the initiated, to the touch of the human hand upon a sick person, or the rubbing with this member any part of the body which might have been in pain, or accidentally injured.

(*g.*) A similar healing ability was attributed to the fingers, especially the index digit. Among the Romans the forefinger was denominated medicus, or the doctor, and it was a very common phrase with them to say *ubi dolor, ibi digitus—where the pain, there the finger*. By means of the hand the magnetic fluid of the body is distributed, and through its application somnambulism, with its clairvoyance and ecstatic trance, are often artificially produced. The finger, as well as the hand, according to the belief of the *magi*, was the instrument through which the Egyptian science of magnetism performed its miracles or wonders; and hence it would appear that the finger was a consecrated object, by means of which such extraordinary effects were produced in the ancient mysteries.

(*h.*) The word surgeon or chirugeon (chirurgia, or surgery) is derived from the Greek (cheir) the hand, and (ergon,) a work, because *the cures were performed with the hand* (quæ manu curat), says Celsus.

(*i.*) In bygone ages the professions of medicine and divinity were inseparable. We read of divinity students learning the use of medical appliances in the school of Alexandria, to which persons resorted who were afterwards to practise either as sacerdotes or leeches (healers).

(*j.*) The Therapeutæ, or healers, and the Essenes (Jewish monks) were one and the same sects. The term therapeutæ is a translation of the Egypto-coptic word, signifying the ability to heal; hence arise the terms surgeons, healers, curates, and doctors.

(*k.*) The healers of the sick generally resided in the temples or rather hospitals, of India, Egypt, and Greece, and they there received those who were ailing, in order to cure them. This object was mostly effected by the *laying on, touching, rubbing, and stroking* with the hand. During this process some of the patients fell into a particular kind of prophetic dream-sleep.

(*l.*) *Diadorus Siculus*, 753 B.C., states that the Egyptian priests, their pupils and patients were inspired by the goddess Isis during their (clairvoyant) dreams, with the knowledge of the means of curing themselves of their diseases.

(*m.*) The *instinct*, or rather natural clairvoyance (clear-seeing), of distinguishing remedies for ailments is possessed in a measure by animals; and it is especially exhibited by the artificial somnambule produced through mesmerism. People in their common sleep have been known to naturally dream, as it is termed, of certain remedies, through the agency of which they were cured of their ailments.

(*n.*) *Æsculapius* delivered oracles *in a dream* for the cure of his patients. The sick who visited the temples to be healed, passed the night in the sanctuary of Æsculapius, and were said there to receive revelations of remedies in dreams for their ailments.—*Cicero.*

(*o.*) *Hippocrates*, 460 B.C., stated that the soul retires into the innermost part of the body, abandons all external operations, and points out everything connected with the corporal functions, and in relation to itself recognises everything as actually present. The prognosis (to know beforehand) of Galen often occurred to him in his perceptive spirit-dreams or clairvoyant condition, as seen in the case related concerning Sextus the Senator.

(*p.*) *Apollonius Tyanæus* was a *clairvoyant* and *clairandient* physician, and studied physics, psychology, and metaphysics, as practised by the priests in Egypt, Delphi, and Rome. Temples were erected to him. He travelled in India, Persia, and Egypt, settled at Ephesus, and there died at the age of 97. The miracles, or rather cures, he performed, were opposed by the later Pagans to those of Christ.

(*q*.) The more profound inquirers among the ancient Magi were aware that the development of the spiritual or physical phenomenon which is now called *clairvoyance*, *spiritual perception*, *lucid vision*, *second sight*, *prophecy*, or *actio in distans*, proceeded from a faculty of the sonl, when freed from the obstructing fetters (as commonplace circumstances and business habits) of the material organisation, and thus left unshackled to exercise its own inborn energies.

(*r*.) According to Celsus, Asclepiades produced sleep by means of *certain frictions* made on those affected with *frenzy*. It happened frequently, according to the same author, that *too much* friction plunged the patient into a state of deep lethargy.

(*s*.) Somnambulism, or sleep-walking, also termed noctambulism, noctesurgiam, and ecstacy, &c., appertaining to the human system, ensues in certain disturbed and unhealthy conditions of the body or brain and nervous system. It must not be forgotten that the so-called *spiritual exaltation* takes place in the day as well as by night. These sleep-walkers have frequently been known to perform a variety of operations with ease and exactitude, which would have required the utmost vigilance of a person fully awake. These afflicted individuals, though entirely deprived of the use of their natural or common organs of external sensibility, read, write, and often perform difficult and dangerous feats, which no sane man would ever think of executing if awake, or in his normal condition. The eyes of natural somnambules are usually closed, but in some instances they are found to be more or less open. These conditions also sometimes occur when sleep is induced artificially as by the human magnetiser's hand.

(*t*.) *Noctambulism* is not, we may observe, unfrequently complicated with certain morbid states of the mental disposition and corporal system, such as *melancholia*, *epilepsy*, *St. Vitus's dance*, *hysteria*, *catalepsy* (immovable seizure of the body), inflammatory and intermittent fevers, worm complaints, &c. Certain forms of somnambulism have often been mistaken for temporary delirium, or actual insanity. Very many of those unfortunate persons who are now in madhouses would undoubtedly be dwelling in their homes, employing all the natural senses for the welfare of themselves and family, if their medical advisers had known and employed the use of animal electro-magnetism and other manual and remedial appliances.

Health, like disorder and disease, can be communicated to our fellow creatures. This knowledge enables the mesmeriser to cure all the above maladies, including ecstacy, sleepwalking, and even chronic madness, as before noticed.

(*u.*) It may be desirable to here call the attention of the reader to the *discovery* and *origin* of the use and efficacy of the *vital electric fluid* of the human body.

(*v.*) It has been noticed in all eras and in every clime—among savages as well as the most civilised—that some *natural somnambules* would at periods rise from their accustomed couch of repose for the purpose of visiting some sick or diseased person, who might be dwelling near them. These noctambulists, when followed, have generally been observed, after leaning forward, as if to regard the malady of the patient for a time, to extend the hand with open fingers and pass it over different parts of the sick person, especially attending to the locality which might be ailing. It has also been recognised during these manipulations that the sleepwalker would at intervals breathe over the portions affected, and then make long passes with the hand from the head towards the feet of the suffering individual. It was likewise noticed that at the termination of each movement the *somnambule* would shake the hand, as if to flirt off from the fingers something they might have absorbed from the invalid, on to the ground; sometimes they were seen to dip the fingers in water, and then rub them dry in a cloth. After operating for a time, the sleeping magnetisers would contemplate for awhile the effects produced, and then retire to their usual places of rest.

I myself knew the daughter of a Mrs. Hibbert who would in this sleep sometimes visit her mother at night and hold long conversations of strange import, and sometimes beyond the parent's comprehension. At other periods, if any of the children, or the father and mother were ill, the young lady would, whilst in her noctambulistic state, pay them a visit, and silently, in all the hush of the hour, touch, or pass the hand, and, at periods, breathe over them. After thus occupying herself for a time, she would quietly retire to her own bed. Some years ago a lady, whilst sojourning in Scotland with a friend, became ill. During her sickness she one morning greatly surprised her entertainer by asking who the young person was who paid her a nightly visit *en chemise*, and busied herself in smoothing down so persistently the coverings of her couch, by passing her hands continually over the bed-

clothes. It was afterwards discovered that this attention proceeded from a servant-maid, who subsequently was found to be a sleepwalker, and who in succeeding times acted upon others similarly when they were ill.

(*w*.) From the foregoing incidents, it would appear that there can be no doubt that man was originally taught the animal magnetic mode of healing by the *natural noctambulistic physician.*

Mesmerisers, who are accustomed to induce *artificial somnambulism,* frequently, when opportunity presents, witness their patients act in the same manner as related above, or at least the induced sleepers can and do magnetise the sick, and often express a wish so to do. After mentally examining a patient, clairvoyants dictate the mode of manipulation and the medical appliances that should be exhibited.

Relative to cases of disease cured and the modes of manipulating the different magnetic poles of the body—the author refers the reader to his work on "Homœpathy," and other modern systems, contrasted with allopathy.

SOUND.

336. *Sound.* (French, son.)—To explain the nature and production of sound, the laws of its propagation through the various media which convey it to our senses, and the manner of its action on the organs and the brain with its associated nervous system; and also the modifications of which it is susceptible in speech, music and inarticulate noises, likewise the means, natural or artificial, of producing, regulating or estimating them, is the proper object of acoustics. I shall in the following article consider sound as having an imponderable material existence, resembling light and heat, since like these, it can be reflected and deflected from surfaces, after the manner of solid substances, and can also, similar to light (as witnessed in Professor Crooke's late experiments) produce mechanical effects, as where it shakes a building and even the ground on which it stands. Further, sound acts upon our special senses if thrown into shape as where it *forms* musical notes. It can likewise appeal to the *feelings*, as when creating the cadence or producing a concert. A *negative nothing* could not yield *positive* effects. Moreover, the matter of sound—like heat, light, and electricity, must be associated with, or enter into the composition, of all entities, as demonstrated by the phoneidoscope, telephone and microphone, whether solid, fluid or aerial, and in fact must exist everywhere, even throughout unbounded space; but of course to render it evident to our perceptive faculties, it must, when ejected from certain bodies, come in contact with gravitating or ponderable matter.

337. Sound cannot be called forth in vacuo, by reason, that it is extracted, with the other constituents of the atmosphere, as by the process of exhaustion, through means of the air-pump. It has been lately proved, that if the ringing bell situated under the empty glass, be connected by a wire with the external air, then its sound can be distinctly heard.

As our aerial element becomes condensed, so also must the matter of sound, resident in it, which condition enhances its

sonorous capability, as experienced in the diving-bell; and *vice versa*, as the air is made rarer its sonorous capacity decreases, as witnessed on ascending mountains; a pistol fired on Mont Blanc produces no greater report than a small cracker would have done when bursting in the valley. The sound called forth by the explosion of the meteor of 1719 at an elevation of 69 miles (upwards of 20 miles above our atmosphere) was compared to a broadside from a ship of war, and shook the doors and windows of many houses. (Halley, Phil., Trans. v. 30, p. 978.) This fact shows, that the imponderable matter of sound must have an existence and be capable of developing certain consequences, without being in the presence of ponderable mediums, and also points out, that it is only when coming in contact with gravitating elements, that its presence and capabilities can be made known to us.

Sound requires *time* for its propagation. Thus, the flash of the gun is seen before its detonation is heard. The report of the bursting meteor of 1783 was perceived at Windsor Castle 10 minutes after its disappearance.

338. *The velocity of sound.*—This result is not always easy to determine, as it is increased by the wind—its motion being added to that of the sound; again, it is also retarded as perceived when we are situated where the wind is blowing from us—like the stone thrown into a running stream, waves are produced by it in every direction similar to those effected in the still lake, but it may be discerned, that the ripples going with the current, will arrive at a given distance, before those that are travelling against it. The progress of sound has been variously calculated by different experimenters, but the mean of the whole is about 1,090 feet in a second at the temperature of 32° F. Every additional degree of heat retards sound about a foot in the same period of time; moisture, fogs, and rain appear to make little difference as to its speed. Sound then may be said to travel, in dry air, at 32°, 1,090 feet or 363 yards per second, and at 62° F. 9,000 feet in 8 seconds, that is 12 miles in a minute or 765 miles in an hour, which is about $\frac{3}{4}$ of the diurnal velocity of the earth's equator.

339. *Retardation and spreading of Sound.*—Falling snow, or when it is lying fresh on the ground, obstructs sound, but not when frozen hard. Sound is propagated over water and ice with remarkable clearness and strength. We can hear on the Thames—according to Dr. Hutton—a person read at a distance of 140 feet, whilst on land, the same could only be distinguished

76 feet. Again, at the north pole, a person can hold a conversation with another individual at the space of 6,696 feet or a mile and a quarter.

340. *Distances at which sounds have been heard.*—Dr. Young relates, on the authority of Derham, that at Gibraltar, the human voice has been heard 10 miles across the Strait. Guns fired at Carlscrona were distinguished across the southern extremity of Sweden as far as Denmark, or 120 miles. Dr. Hearn states that he heard guns fired at Stockholm when 180 miles distant. The cannonade of the sea fight between the English and Dutch in 1672 was recognised across England as far as Shrewsbury, and even in Wales, 200 miles from the scene of action.

341. *Every kind of sound travels with equal velocity.*—The sounds of all pitches and of every quality, journey with like speed, as we discern in the musical tones of a band; whatever is the distance that they can be properly heard, they arrive in equal times.

342. *Intensity and conduction of sound.*—A very material difference is observed in the intensity with which sounds are propagated, or the distance at which they may be heard with equal distinctness, according to a great variety of circumstances. Thus if a sound be prevented from spreading and losing itself in the air, whether by a pipe, the vicinity of an extensive flat surface, as a wall, or otherwise, it may be conveyed to a very great remoteness with little diminution of ability, as we know when speaking through pipes. Thus a whisper was heard by M. Bist through 3,120 feet of tubing (used to supply Paris with water), and a pistol fired at one end extinguished a candle at the other, and drove out light substances, placed therein, with considerable violence.

A pin dropped into the well at Carisbrook Castle, which is 216 feet deep, and 12 feet in diameter, can be distinctly heard to fall into the water. The interior of this well is lined with very smooth masonry.

343. *Reflection of sound.*—Audible vibrations, like rays of light, can be reflected as recognised in echoes. For instance, there is one in Woodstock Park repeats 17 syllables by day and 20 by night. In St. Alban's Abbey the tick of a watch may be heard from one end of the building to the other. In Gloucester Cathedral a gallery of an octagonal form, conveys a whisper 75 feet across the nave. An echo on the north side of Shiply Church repeats 21 syllables. In the Cathedral of

Girgenti in Sicily, the slightest whisper is borne with perfect distinctness 250 feet. An echo in an old palace near Milan, repeats the report of a pistol 60 times.

344. *Reverberation of sounds from clouds.* — The rolling thunder is no doubt produced from the clouds reflecting the sound one to the other. It has been noticed that when cannon are fired, if the sky is clear, there is only one single report, but when there are many clouds, the answering detonation is like thunder, and double and treble sounds will arrive from a single discharge of the gun. Two blows equally loud, and *precisely the same distance from the ear*, will sound as one stroke of double the intensity, and so on with any number of percussions.

345. *Undulatory vibrations.*—We mostly have waves in gentle currents of the atmosphere without sound, and also in the quiet streams of the ocean, and we likewise have sound without discernable undulations, as displayed by the telephonic apparatus. Again, currents of electricity and magnetism, have, like sound, a vibratory, or bowed, ellipsoid course. In fact, all entities—when free to move—whether solid, fluid, aerial or imponderable, assume during change of place, or otherwise, a curvilinear or wave-like motion. Further, when audible waves of sound are zigzag, or irregular, in outline, and especially if at all vehement, the matter of sound then occasions, or produces, *noises*, but when this sonorous element is thrown into *form*, it now creates *melody*, or *tune*.

The oscillations in a field of standing corn as a gust of wind passes over it, give the idea of the motion of a wave; we see the vibrations which are occasioned by the *impress* of the breeze, acting like a mould, or matrix, on yielding surfaces.

346. *Effects of hydrogen on the voice.*—This very subtle gas would appear to have but little of the material element sound diffused through it, which circumstance, combined with its rarity, causes, when breathed, the voice to become very feeble and shrill in pitch. During combustion this gas evolves singular acute sounds when passed through certain tubes.

347. *Propagation of sounds through fluids.*—Liquids being slightly elastic and more dense than gases, transmit sound better than the air. Mr. Anderson from this fact concluded that fishes were devoid of hearing, because they appeared insensible to the sounds produced in the atmosphere, but

when the slightest noise was made *in* the water or *upon* the glass globe containing these animals, they immediately noticed or *felt* it, though they have no ears, or at least no external auditory organs. People also when diving recognise noises faintly, if made in the air; and at twelve feet deep they could scarcely hear the report of a gun. One diver holload under the water, but was scarcely heard by the persons in the air.

Franklin, having plunged his head below the water, caused a person to strike two stones together beneath its surface, and he heard the blows distinctly at the distance of half-a-mile. Sound flies through sea-water at 4,921 feet per second, according to M. Beaudant, but M. Colladon gives 4,708, which is perhaps more correct; this latter gentleman by plunging vertically into the water—a tin cylinder three yards long and eight inches in diameter, closed at the lower end, and open to the air above, was enabled to hear the strokes made on a bell under water nine miles distant, across the whole lake of Geneva. He also noticed that the sound of a bell struck under water, when heard at a distance, has no resemblance to its sound in air. Instead of a continued tone, a short sharp noise is heard, like two knife blades struck together.

348. *Propagation of sound in solids.*—Certain hard bodies are equally well or better adapted for the conveyance of sound than fluids, as is the case with some of the metals. The quality of resilience appertaining to many of these dense bodies capable of transmitting sound, has been called in the schools *elasticity* (see article on "Elasticity"), but I object to this term as applied to the recoilment of one substance from another after percussion; in fact it is a modern meaning given to this word, not to be found in Bailey, Johnson, or any other dictionary, and, therefore, is calculated to mislead rather than explain the cause of this property in certain materials. The word elastic, as used in common parlance, is explained by lexicographers, as being that ability in bodies by which they endeavour to restore themselves or return by a springy capacity to the form from which they have been bent or destroyed; in other words, elasticity may be defined as that property of bodies, by virtue of which, they admit of change either of size or form from the application of some external control, resuming, upon the suspension of that control, their proper shape or volume. The most elastic bodies in nature are gases and vapours, and *vice versa* as regards fluids. The

inherent cause of the rebounding of one material from another, is the result of an electric reaction; for instance, balls of india-rubber, cork, bone, and resin, are very bad conductors of electricity and heat, hence their true resilient property and incapacity to convey sound, but metals, which are very compact and hard readily transmit the sonorous principle; yet they have very little recoiling ability. (See sec. 40, and article "Resistance.")

349. Returning to the propagation of sound in solids. One important condition in their constitution as regards this ability, is homogeneity of substance and uniformity of structure. The effect of want of homogeneity or like character, in a medium on its ability of propagating sound, is precisely analogous to that of the same cause in obstructing the free passage of light, and for the same reason. The sonorous pulses, in their passage through it, are at every instant changing their medium. Now at every change of medium, two things occur; first, a portion of the wave is reflected, and the intensity of the transmitted part is thereby diminished; secondly, the direction of propagation of the transmitted part is changed, and the sonorous rays, like those of light, are turned aside from their direct course. Thus, the general wave is broken up into a multitude of non-coincident waves, emanating from different origins, and crossing and interfering with each other in all directions. Now, whenever this takes place, a mutual destruction of the undulations, to a greater or less extent, arises, and the sound is obstructed and stifled. Further, as the parts of a non-homogenous medium differ in elasticity, or rather conductibility, the velocities with which they are traversed by the sonorous pulses also vary; and thus, among the waves which ultimately arrive at the same destination in the like direction, some will reach sooner, and others later. These, by the law of interference, tend materially to destroy or neutralize each other.

350. But of all causes which obstruct the propagation of sound, one of the most effective is a want of perfect adhesion at the junction of the parts of which such a medium consists. The effect of this may be conceived by regarding the superficial strata of the molecules of each medium when in contact, as forming together a thin film of less elasticity, or rather conductibility than either; at which, therefore, a proportionally greater reflection of the waves will take place, than if the

cohesion were perfect, just as light is much more obstructed by a tissue of cracks pervading a piece of glass, than it would be by any inequality in the composition of the vitreous substance itself.

Again, as long as effervescence lasts in champagne, and the wine is full of air-bubbles, the half filled glass cannot be made to *ring* by a blow on its edge, but gives a dead disagreeable sound, whilst as the effervescence subsides the tone becomes clearer, and when the liquid is perfectly tranquil the glass can then ring as usual, but on re-exciting the bubbles by agitation, the musical tone again disappears. To understand the cause of this, we must consider what passes in the communication of vibrations through the liquid from one side of the glass to the other. The vessel and its contained liquid, to give a musical tone, must vibrate regularly in unison as a system, and it is clear, that if any considerable part of a system be insusceptible of regular vibration, the whole must be so.

351. Sounds are more audible by night than by day, owing to the uniformity of the temperature of the atmosphere by night, when upward currents of air, heated by their contact with the earth under the influence of the sun's rays, are no longer continually mixing with the upper strata, and disturbing the equilibrium of temperature. It is obvious that sound, as well as light, must be obstructed and dissipated from its original direction by the mixture of air of different temperatures, (and consequently elasticities) and thus the same cause which produces that extreme transparency of the air at night, required by astronomers, renders it more permeable to sound. There is no doubt, that the dead silence prevalent at night renders our auditory nerves (or that portion of the brain connected with them) sensible to impressions, which would otherwise escape them.—(See article "Optics," sec. 19.)

There is an exception to this latter economy with deaf people, who hear best when the nerves of the sensorium are put on the stretch, so to speak, as when they are riding in a carriage, or are near machinery whilst working, and also during the roll of the drum. Again, people confined in silent cells often become deaf from disuse of the organs that appreciate sound. Further, we hear better in cold than in warm weather, owing to the density of the atmosphere, during the prevalence of the former.

352. Sound in mixed gases varies only with their elasticity. In hydrogen the velocity of the pulsation is nearly three times

its celerity in the atmosphere. In azote and oxygen the velocities are so nearly alike, that little obstruction can arise from its influence, so that as far as the phenomena of sound are concerned, atmospheric air may be looked upon as a homogeneous medium. If saturated with aqueous vapour, at high temperatures, however, it is possible that the effect may become sensible, and perhaps to this cause may be attributed the phenomenon of the occasional duplication of the sound of a gun heard from a great distance, a part of the sound being transmitted more quickly than the rest by aqueous vapour, or even by water in its liquid state, suspended in the air. If this be the cause, sound might be expected to be heard double in thick fogs, or in a snow storm. But the remarkable obstruction to sound caused by fog, and especially by snow, would probably prevent any sound from being heard far enough to permit the interval of the two pulses to be distinguishable. To the foregoing we may add the well-known effect of carpeting, or woollen cloth of any kind in deadening the sound of music in an apartment. The intermixture of air and solid fibres in the carpet, through which the sound has to pass, deadens the echo between the ceiling and floor by which the original sound is swelled.

353. There are two very important particulars in which solids and fluids differ in conducting sounds; 1st, the molecules of fluids are capable of displacement among themselves. Those of solids on the contrary, are subjected to the condition of never sensibly changing their order of arrangement; 2nd, each particle of a fluid is similarly related to those around it in all directions; relative to solids each molecule has distinct surfaces, and different relations to space and to the surrounding particles. Hence arise a multitude of modifying causes, which must necessarily affect the propagation of sonorous pulsations through solids, which have no place in fluids; and modes of vibration become possible in the former, which it is difficult to conceive in the latter, whose parts have no lateral adhesion. Thus we may conceive pulses propagated in solids like those of a chord vibrating transversely, in which the motion of each molecule is transverse or oblique to the direction in which the general pulse is advancing.

354. The conducting ability of wood along the grain is very remarkable. If any person apply his ear close to one end of the longest stick of undecayed timber, and an assistant at the other extremity scratch with the point of a pin, or tap so

lightly with its head as to be inaudible to himself, every scratch or tap will be distinctly, nay, loudly heard at the other end as if close to the head of the listener. This result is like the wave travelling along the loose rope, or whip, produced by means of the hand, (see article "Optics," sec. 8,) the pulsations gain energy as they proceed, and the matter constituting sound and electricity become aroused into more vivid action, and re-operate after the manner of the echo in a cavern, where the reverberation of sound is increased and redoubled within certain bounds.

In general, however, all solids, if tolerably compact, conduct sound well, and transmit it rapidly. Thus a blow of a hammer against a rock produces two sounds, which separate in their progress; that propagated through the stone arriving almost instantaneously, whilst the sound conveyed by the air lags behind, as well known in the process of blasting rocks. The telephone shows the same results with regard to wires.

When sound is conveyed along wires, or iron pipes, it travels at the rate of 11,090 feet per second, at the temperature of 51° Fahr. This is about $10\frac{1}{2}$ times faster than its velocity in air.

355. Sounds in general spread in all directions; but a tuning-fork being struck sharply, and then held by the handle against a substance, is set in vibration, the two branches of the fork alternately approaching to and receding from each other. Each of the prongs, consequently, throws the air, or its constituents, into vibration, and by resting the fork upon certain solids, a musical tone is produced. But this sound is very unequally audible in different directions. If the axis of the tuning fork, or the line to which it is symmetrical, be held upright about a foot from the ear, and it be turned round this axis while vibrating, at every quarter revolution, the sound will become so faint as scarcely to be heard; while at the intermediate axis of rotation it is heard clear and strong. The audible situations lie in lines perpendicular and parallel to the flat faces of the fork, the inaudible at 45, inclined to them. The forms of bodies, when giving off sounds, have a great influence on the quality and direction of the sonorous waves. (See "Optics," sec. *r*.)

356. The reflection and refraction of sound from oblique surfaces obey the same geometrical laws with those of light.

357. *Of the nature and production of musical sounds.*—Every irregular impulse, communicated to the air and the surrounding

bodies, produces what is called a *noise*, in contradistinction to a musical tone. Each noise has its particular character, as the crack of a whip, the blow of the hammer on a stone, or the report of a pistol, showing that each body from which sounds emanate, *gives to that sound certain qualities*, dependent on the character, shape, and composition of the substances from which they were evoked. A musical sound is said to be a succession of impulses, at equal intervals of time. To this assertion I would add that these pulsations to produce a melodious tone must assume a particular curvilinear ventral section, or semiovoid form, which can be demonstrated by Chladni's apparatus. (See sec. 40.) Relative to musical sounds, it is further stated, that there are three principal points of distinction, viz., the *pitch*, the *intensity*, and the *quality*. Of these the intensity is said to depend on the violence of the impulses. I would observe that this is true in respect to noises, but not as regards a musical tone. Thus, if we press heavily, or with too much energy, on the edge of the musical glass, or bear down with the fiddle-bow, or strike too energetically the pianoforte keys, and likewise if we make use of too much strain in propelling air through musical pipes, we shall produce from each melodious apparatus only a confused noise, or a note that is not penetrating or intense, from want of proper *shape* and smoothness of its outline. To bring forth, or evoke, a characteristic perfect tone, we must commence with a gentle effort, which by *electrical action* (see sec. 40) will cause the continued flowing pulsations to assume certain ventral sections, or semiovoid *forms*. It is this *evenly* curved outline of the undulations that produces the exciting or *intense* tone in question. Of course the pitch and unison of each distinct note will depend on the number of smooth pulsations made, or incited into action in a given time, and also upon the size of its ellipsoid-shaped waves; but the *quality* will be contingent upon the evenness, or regularity, of the curvilinear outline making up each undulation. No vibrations of the air (which is merely a vehicle for melodious tones) could possibly produce a musical note, this evolution depends upon the instrument and certain *solids* that are capable of throwing the imponderable material element constituting sound, into distinct forms, thus creating each separate note. This result is perfectly independent of what the French call *timbre*, or those particular distinctive *noise-sounds* that appertain to our various musical instruments, and which accompany the

melodious tones evoked from them. The electric thunders may roll and reverberate among the clouds, and the storm-blast roar, and when subdued into the gentle breeze, may whistle as it drives or plays against and over irregularly-shaped objects; but these are noises, and can wake up no conception of a musical tone. Further, the humming sometimes produced by machinery, or the buzzing from the beating of the insects wing, and the chirruping produced by the cricket, and grasshopper, &c., are not even an approach to musical notes, but merely, as regards the tempest, astounding noises; and in respect to the zephyrs and insect-energetic efforts, they are only attractive sounds, which could never wake up, or cause the *nerve-loops* constituting the cerebral organ of melody to vibrate, so as to excite the sensation or feeling generated by musical cadences.

In addition, the singing, as it is termed, or rather—when too near—noisy warbling of birds, which give expression to their happy feelings, are no more musically-*formed* notes than the utterances produced by other animals. It is true that some of the feathered race can be *taught*, like the human being, to vocalise certain strains, as instanced by the piping bullfinch; but the natural carolling of birds may in a manner be associated with the oral recitative, or chanting words, *hummed* forth by man. In fact, it will be found, on examination, that there is no half or whole tone which can be educed from musical instruments that at all resembles the sounds produced by machinery, or naturally evoked by animals.

It may be here noticed that when a musical band is heard at a certain distance, the educed strains will impinge on the senses with little, if any, *timbre*, and in correct harmonious unison, although certain of the performers may have called forth their separate parts rather discordantly, or out of tune, by producing musical undulations having a zigzag outline, which is only an approach to the contour that characterises a defectless tone. The perfected result as regards the musical notes in question, ensues by reason that each tone is endowed with a particular elastic quality, which probably enables it, when evolved with its outline uneven or puckered, to right itself, as it sweeps along, so as to form, or unfold, into a smoothly-curved and semiovoid musical wave. (See sec. 40.) Again, if a very indifferent player, who is recognised, when near, to call forth harsh tones, owing to their having irregular

outlines, be requested to remove to a certain distance, his then evoked notes will reach the listener's ear in a corrected state or form, and will no longer disturb the auditor's organ of melody. In addition, the *timbre* and noises only travel a short way, whilst the perfected note continues onwards. It may be here further noticed that the *form* and number of pulsations of a given musical tone will be the same, however varied the apparatus may be from which it is elicited. Thus, certain performers have been known to call forth a perfectly smooth clear note, without any *timbre* appertaining to the instrument they may have played upon. For instance, I have heard Paganini educe from the violin, Bottisini from the double bass, and Herr Kœnig from the cornet à piston, and others from the flute, and even the jews'-harp, notes quite as clear as the vocal tones created by the most accomplished singer; thus showing that the soul, by means of the nervous system, can announce its feelings, and create from crude sound-matter perfect musical notes, like as the sculptor carves into being—out of stone—the model resident in his mind's eye.

The sirene—an instrument invented by Baron Cagniard de la Tour—sounds equally perfect if plunged in water and fed by a current of that fluid as when played upon in air; thus proving that it is the instrument alone that gives an *undulatory form* to the matter of sound resident in the above elements. The shape and pitch of the vibrations then, do not depend alone on the nature of the medium in which the sound is created. Thus air, water, wood, and especially the metals (as exemplified by the telephone) are conductors and feeders—so to speak—of the melodious sounds, thrown into *vibratory form* through the agency of certain shaped musical instruments. To properly meet the economy of the laws of sound, all musical apparatus should doubtless be made oval or smooth and curviform, and likewise the sides and roof of the rooms wherein these instruments are exercised, thus adapting their surfaces to the ovoid sonorous undulations that may be created or rather called into action by performers. There was a celebrated Mr. Potter, of Bristol, some eighty years ago, who was accustomed to construct many of his flutes *oval* instead of round, the former, made of metal, were very much appreciated by amateurs for the exquisite clear and mellow tones that could be elicited from them. There can be little doubt that all tubes which are designed to evolve pure and sweet notes, should be made oval, similar to these flutes, or

shaped like the mouth preparatory to whistling, thus adapting them to the form of melodious undulatory pulsations.

The tones from the horn are rendered more intense or effective by curving the tube on itself; this proceeding enhances or gives energy to the blast produced, and also causes the sound to be heard at great distances.

It has been stated by all sensitive musicians, that bad players injure good instruments, and *vice versa*, that apt performers improve indifferent musical apparatus. This is the chief reason why fine musicians never allow inferior performers to play on their favorite instrument, even though it were a pianoforte, which to preserve in good and effective order, must never have its keys exercised when out of tune. There can be no question that the tones produced by a skilful performer, establish certain even or true channels, through which his evoked melodious sounds undulate as they permeate the instrument; whilst an inferior musician produces irregularly curved or unevenly formed tones, which break up the smooth conduits established by the able master.

Motory ability of musical tones.—The pealing organ, by sonoro-electric action, can cause a large building, and the earth on which it stands, to tremble, which phenomena may be readily felt through the whole body, thus calling forth particular motive effects, that no loud *noises* or boisterous hurricane could create or educe. Further. It is well known to musical performers that whilst exercising their vocation in certain rooms; some of the things there present – especially when particular strings of the instrument are in action—will tremble and react back in response to a given evoked tone. Thus, sometimes in calling forth a special note, the player finds it becomes very unsteady, or is not clear, and on seeking the cause of the interruption he finds that it appertains to some loose ornament situated in the chamber, or a piece of furniture, as the looking-glass or a broken pane of the window, &c., and if this object be removed or prevented from throwing or echoing back its responsive or reacting vibrations—the note in question becomes clear and effective. Instrument-tuners are, some of them, perfectly aware of this fact, and now and then, whilst at their occupation, can by seeking, discover the material, producing the disturbance or interfering with the pulsations of the string or pipe they are essaying to put in tune; of course it will be found that on removing this answering sympathetic—so to speak—trembling object, the

note they wish to educe, becomes freed from the impediment that thwarted its proper action.

358. *Relative to the vibrations of musical strings or chords.*—If a string or wire be stretched between two fixed pins, or supports, and then struck or drawn a little out of its straight line and suddenly let go, it will produce a twanging noise, and at the same time vibrate to and fro, until its own rapidity, and the resistance of the air &c., reduce it to rest; but if a *resined bow* be drawn across it—producing an *electric* action—the vibrations are continually renewed, and if attached to an instrument, a musical sound is *formed* and heard corresponding to the *size* of the ellipsoid wave and the *rapidity* of the pulsations.

359. A chord, although vibrating freely, may yet have any number of points *equally* distributed at aliquot parts of its length, which never leave the axes, and between which the vibrating portions are equal and similar, and lie alternately above and below the axis, and in reversed positions as to right and left. Such points of rest are called nodes or nodal points, the intermediate portions which vibrate are termed *bellies* or ventral segments. (See sec. 40.)

360. If a string in the act of vibrating be touched in any part so as to reduce that point to rest and retain it in the axis, then if after the contact it vibrate at all, it will divide itself into a number of ventral parts similar and equal to each other, and separated by nodes, and each of these will vibrate as if the other had no existence, but act as if the nodes were fixed points of attachments.

361. If the string of a violin, while maintained in vibration by the action of the bow, be lightly touched by the finger or a feather, exactly in the middle or at one-third the length, it will not cease to pulsate, but its undulations become diminished in extent and increased in frequency, and a tone will be audible, fainter, but much more acute than the original, or, as it is termed, the fundamental note of the string, and corresponding in the former case to a double, in the latter to a triple rapidity of vibration. The note heard in the former case being the octave, in the latter the twelfth above the fundamental note. If a small piece of light paper, cut into the form of an inverted V, be set astride on the string, it will be violently agitated, when placed in the middle of a ventral segment, while at a node, it will ride quietly as if the string were (as it really is at these points) at perfect rest. The sounds thus produced are termed harmonics.

362. It was long known to musicians, that besides the principal or fundamental note of a string, an experienced ear, or rather organ of *melody*, could detect in its sound when set in vibration—especially if very lightly touched in certain points —other notes, related to the fundamental one (as the 3rd and 5th) by fixed laws of harmony, and which are called therefore harmonic sounds. They are the very same, which, by the production of distinct nodes, may be insulated, as it were, and cleared from the confusing effect of the consistent notes or sounds. They are, however, much more distinct in bells and other sounding bodies than in strings, in which only delicate ears or rather acute melodious senses can detect them.

363. If two chords equally tense, and in all respects similar, but one only half, one-third or aliquot part of the length of the other, is placed side by side, and the shorter be struck or sounded, the vibration will be communicated to the longer, which will at once be thrown into a node of pulsation, in which the whole length is divided into ventral segments, each equal to the shorter string. This is said to take place through the intervention of the air, or r ather, action by presence. But this motive effect can be conveyed by means of a strip of wood, or a wire from the string or chords of one instrument to that of another, placed in an adjoining room, the chords of which latter will there be found to vibrate as if from sympathy, or rather sonorous inoculation, and give out the musical tone or tones evoked in the contiguous chamber, as exemplified by the telephone. In the pulsations of chords, which from their small surface can receive but a trifling impulse, the sounds and motions excited by this sort of sympathetic communication, or rather *grafting*, are feeble, but in vibrating bodies, which present a large surface, they become very great. Thus, a person with a clear and effective voice, can break a drinking-glass by singing its proper fundamental note close to its mouth. Looking glasses have also been occasionally fractured by sonoro-electric musical performances. The excursions of their molecules in the vibrations into which these articles were thrown being so great as to strain them beyond the limits of their cohesion.

364. The pitch of the sound of a pulsating string depends on the number of vibrations made in a given time; its quality, of course, will result partly from the nature of the string, and especially on its equality of thickness, besides which much may be contingent on the form and extent of the wave excited into action, or of the curve into which it is thrown. In instruments

like the violin, played with a bow, or the harp, where the string is drawn out of its position and suddenly let go, this curve is probably single, and occupies the whole length of the string; but in the pianoforte, where the chords are struck near one extremity with a sharp sudden blow, the vibrations consists in an elevation, or bulge, more or less extensive, running backwards and forwards. (See sec. 40.)

There will, of course, be a difference of the tone according as the keys are struck, with quick, short blows, or gently pressed, and the duration of the contact of the hammers with the strings, prolonged for an instant of time, giving rise to a more moderate but sustained *tenuto*-effect, by bringing a larger portion of the string, or even the whole into motion at once, so as to make the notes of the pianoforte *sing*, as it is termed by musicians. But whether the portion disturbed at once be large or small, and it occupy the whole string, or run along it like a bulge in its line; whether it be a single curve, or composed of several ventral segments with intervening nodes, the motion of a string with fixed ends, is no other than an undulation, or pulse, continually *doubled back on itself*, and retained constantly within the limits of the chord, instead of running out both ways to infinity. But we must not forget that as the perfected tone is thrown into its correct form, it acts more or less on all the surrounding bodies, and wakes up, or calls forth in them, as if by electrical excitement, a reaction, which reactive operation varies, according to the shape and composition of the adjacent substances in question. Some of these will be found only to tremble; but if it be a stringed instrument, then its like chord will pulsate, and by sympathy, and re-echo the note (and sometimes its harmonics), which first excited it into vibratory action.

It is impossible to evoke a perfectly-formed note from any instrument by pulling its strings with the fingers, as in playing on the harp, or guitar, &c. To produce, or create, an efficient melodious tone, it requires a period, or certain length of time. Further, this perfected note is chiefly educed through *electrical friction*, either by means of air, as in whistling, or by passing this element through pipes, or over strings, as with the Æolian harp, or by the application of certain solids, as when using the resined bow. The *pizzicata*-touch of the violin, or the twanging sounds produced by the digital pulling of the strings of other instruments, are only half-formed notes, so to speak, that *die in their birth*, and can never cause surrounding bodies

to vibrate, or the nerve-loops of the organ of melody to tremblingly undulate; hence these *thrummed* forth notes fail to produce that entrancing and delicious feeling which is created when these organic cerebral fibres are acted upon by matured or perfectly-formed melodious tones. Very sensitive and highly practised musicians dislike listening to, and especially avoid playing, an instrument of the harp kind, which implements originated in those ages when men were ignorant of whole or perfect tones and harmonious transitions. These inefficient instruments must, one of these days, like the spinet and harpsichord, disappear, as will certain other mechanically-arranged musical apparatus, upon which no *expressive* effects can possibly be produced; as the organ, for instance. This latter instrument fails to wake up the feelings that are called into being by such musical implements as the flute and violin, and especially breathed forth by the tuneful human voice; because whether the keys acting on the valves of the pipes belonging to the organ be touched by the fingers, or pressed downwards by weights, or other mechanical means, the same characteristic sounds will be produced.

365. *Vibration of a column of air of definite length.*—All propositions which are true of a vibrating chord are also conformable to fact of a pulsating cylindrical volume of air. A vibrating chord is susceptible of division into several aliquot parts, all undulating simultaneously; so may the aerial column in a stopped pipe pulsate in distinct ventral segments. Precisely, too, as in the vibrations of strings, any number of these modes of undulating may go on simultaneously. Such combined modes may be produced by an expert fluteplayer, by a nice adjustment of the energy of his breath; at least, the octave of any note can be obtained, and distinctly heard with the fundamental tone.

366. That it is really through the operation of electricity produced by the friction of the air that calls into action the imponderable matter of sound resident in the atmosphere, is shown (relative to the tones elicited when playing the flute, organ-pipe, or other wind instruments), from the fact that, with the exception of the *timbre*, the materials, as regards thickness, or other peculiarities of the tube, are of no consequence; for instance, a pipe of lead, glass, or wood, provided the dimensions be the same, produce, under similar circumstances, exactly the same tone as to *pitch*. If the *qualities* of the tones produced by different pipes vary, this is to be

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OF

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AND

RESISTANCE:

ALSO

AN ENQUIRY INTO THE MATERIALITY

OF

ELECTRICITY, HEAT, LIGHT, COLOURS, AND SOUND.

To be Published Monthly.

BY

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becomes a most delicate detector of aerial pulsation. Suppose a circular disc of glass, held concentrically over its plane, parallel to that of the membrane, and set in transverse vibration, so as to form any of Chladni's acoustic figures—then will this figure be imitated exactly by the sand on the membrane. Now let the vibrating disc be shifted laterally, so as no longer to have its centre vertically over that of the membrane, but keeping its plane as well as that of the membrane horizontal, still the figures marked out upon the latter will be fac-similes of those on the disc, and that whatever be the extent of lateral removal, till the vibrations became too much enfeebled by distance to have any effect at all. The membrane, be it observed, will vibrate in sympathy with *any* noise, but every particular sound will mark out on its own individual nodal figure, and as the pitch, &c., varies, the figure also alters. Thus if a prolonged note be elicited from a flute near it, each tone will call up a distinct form, which the next note will efface to establish its own impression. Showing that each harmonious sound has its particular outline, and can excite into shape or write its own image in or upon loose or moveable dead matter. These facts point out to us after what manner each musical note can incite the strings of instruments into vibratile operation, and likewise the living nerve-loops—that constitute the organ of *melody*—into trembling action, which result calls forth those feelings that appreciate harmonious productions.

370. That undulatory sound-waves travel in ellipsoid or semiovoid curves, is shown in one way, by the shape of the external ears and the membranous tympana of land animals—and further, the bone and channels appertaining to the internal organ of hearing, is still more marked relative to their adaptive or receptive capability for these pulsations, thus enhancing the form or shape of the vibrations that are to be appreciated by the wavelike curved nerve-loops, or fibrellæ of the brain, &c.

371. One of the most interesting purposes to which M. Savart has applied the properties of membranes, is to explain the actual state of the air in the different parts of a vibrating mass of a determinate figure, as to motion or rest. For this purpose, the musical sound should be excited and maintained by a constant cause at a high degree of intensity, especially if the mass of air be large, as in a chamber or gallery; and to give the membrane the greatest possible sensibility, it ought

to be stretched so as to be properly in unison with the note sounded, so as to act as a receiver and condenser of small aerial motions. The greatest purity and intensity of the sounds to be employed for this purpose, may be obtained by one of Dr. Franklin's *harmonica* glasses, or the bell of a clock, maintained in vibration by a bow, and this may be still further augmented by adapting to it a resonant cavity, as, for instance, a large cylindrical vase, closed at one end, and of such dimensions as separately to vibrate the same note. The tones thus produced with large *harmonica* glasses, are of such intensity, that no ear can long support them, and at the same time, they are rich and of a mellow quality. Being provided with the above apparatus, suppose we shut ourselves up in an apartment of regular figure, and free from furniture or projection from the walls, and recesses, &c., and place a resonant cylinder with its axis horizontal, and the vibrating bell or glass opposite its orifice. Then in the direction of its axis, arrange the membrane on a level with its proper frame and resonant cylinder below it, and now strew the horizontal surface with sand. If we then place the membrane thus armed very near the source of the sound, it will vibrate with great energy. As we withdraw it (keeping it still in the line of the axis of the first resonant cylinder) its vibrations will diminish gradually, and at length cease, after which (still continuing to remove it along this line) they will recommence and reach a maximum, at a point when their intensity is nearly equal to that close to the source of sound. Removing the membrane yet further, a new point of indifference is found, and so on until we reach the end of the chamber. If we walk along the same line, keeping the ear in the plane of the level axis of the resonant cylinder, we shall perceive the sounds to be much louder in the places where the vibrations of the membrane attain their maximum, than at the intermediate points where they are at a minimun. At these latter, when the auditor moves his head away from such a point towards the *right* (always supposing it to remain in the line of the axis above mentioned) the sound will appear to come *from the right*, and if towards the left, it will seem to come from the left, whether the original source of the sound be to the one or the other side. This singular effect shows that the aerial molecules, &c., on either side of the point of indifference, are in opposite states of motion at any given instant. In making these experiments the head should be turned, that the axis of the resonant cylinder so prolonged

shall pass through both ears. Suppose for instance, the sounding apparatus to be to the observer's left, and that his head be very near it, the sound will appear to enter the left ear. As he removes further away, so as to pass one of the nodes, it will seem as if the sound had changed sides, and now came from the right. When another node is past, it will appear to have again shifted to the left, and so on. (See sec. 40.) But if we quit the axis of the cylinder, and carry an exploring membrane about the apartment, noting all the points where it vibrates most forcibly, allowing ourselves, as it were, to be led from spot to spot by its indications, we shall trace out in the air of the room a set curve consisting of double curvatures marking the maximum of the excursions of the aerial molecules. If the experiment be made in a gallery, or passage, whose length is its principal dimension, the curve will be found to be a kind of spiral creeping round the walls, floor, and ceiling, obliquely to the axis of the gallery, thus presenting a marked analogy to the disposition of the nodal lines in a long rod or wire vibrating tangentially. In exploring the vibrations of the air in an apartment with an open window, the spiral disposition of the vibrating portions was found to be continued out of the window into the open air, the lines of greatest intensity running out in great convolutions which seemed to grow wider on receding from the window, and could be traced to a great distance from it and imperceptibly extended, no doubt—lessening in intensity—for thousands of miles, like the results demonstrable through the telephone.

372. Vibratory motions are communicated through liquids precisely as by gases and solids, without change of character or direction. This explains how the nerves of hearing, which extending throughout the convolutions of the labyrinth of the internal ear, and being immersed in the liquid which fills it, transmit to the sensorium, not only the general impression of sound, but of the direction in which it comes.

373. It should be borne in mind that every mechanical and physical operation must commence through, or emanate from, the agency of either spiritous, as heat, light, electricity, &c., or spiritual elements, as the vital principles of plants and animals, and the acme of these existences, the human soul. In addition, there can be no question that a *sonoro-electric fluid*, like the matter of heat, enters most intimately into the composition of all entities, be they solid, fluid, or aerial. And further, it may be stated that no noise, or sound of

any kind, can be produced, as made evident to the senses, without being preceded by some form of electrical action. The strongest wind makes no noise except when it is forced against some obstacle. The rolling thunder appertaining to the storm-cloud, is produced from electrical discharges; and again, the whispering of the wind, and the murmuring of the running stream, are brought about by the action of the electricity elicited from the friction of these elements against the bodies they may come in contact with. Further, most of the explosive noises that take place, may be referred to thermo-electric action.

374. Relative to the harmonious compositions educed from musical instruments, they are the results, as before suggested, of electrical friction; but the melodious airs breathed forth from the human vocal organs, in addition to their electrical sources, are governed originally by the soul's influence, as the utterings of certain animals are swayed primarily by the operative efforts of the life-principle that rules their systems.

That phonic undulations are of a sonoro-electric character, may be demonstrated by the following facts:—If a tuning-fork be sounded, and while in vibration be touched by the finger, a sensible sonoro-electric shock will be felt at the moment of contact. Again, on blowing into a common flute, and stopping two or three of the higher holes gently, the same sort of sonoro-electric sensation, though in a much less degree, will be felt in that part of the finger-ends which is in communication with the interior air. The fingers should be warm, and if the operator is not used to the instrument, the effect is made more certain by tuning the string of a violoncello to the note which is to be fingered on the flute, and then sounding the violoncello strongly while the latter is held over it with the fingers placed as before. This experiment adds, by sonoro-electric action, to the intensity of the effect. Again, if two persons are singing or whistling, the first and second of an air, with their mouths close together, they will become sensible of electrifying, or electro-magnetising, each other, producing a strange, trembling, yet pleasing sensation throughout their systems. Further, when prolonged musical tones are perfect in the number of their beats, and have a properly curved pulsatory outline (which qualities render them more intense) they impress us with the same kind of electrical sensation; hence people with large organs of *melody* tremble from head to foot

with pleasure, and often exclaim that they feel the music down to the ends of their fingers and toes.

375. That violent and sudden thermo-electric concussions of the air can act at long distances, is proved by the fact that the explosion of a powder-mill will shake the windows in their frames when twenty miles distant. (See "Optics," sec. ix.)

376. When a cannon is fired, the great expansion of the gases which are disengaged by ignition of the powder, together with the thermo-electric energy brought into action, propels the air, and other contents of the gun forward, thus creating a vacuum. It is stated by some that the loudness of sound following after the discharge is caused by the rushing of the air back into the cannon; but it should be remembered that we have a similar result from the presence of electricity within a thunder-cloud, where there is no particular cavity to fill up, and if there was, no noise is ever produced by one portion of air rushing, however violently, against another.

377. It has been stated relative to a musical chord, or a spring, and likewise the drum, &c., that the harder they are struck the louder is the sound, but without any difference of tone, character, or velocity of propagation. This is not correct; the quality of a note, as before stated (see sec. 367), differs according to the character of the stroke applied to the sonorous body, or frictional pressure made upon a string. We can feel and hear a perfectly-formed note (the intensity of which increases according to its clearness), at a more remote distance than a melodious tone that is irregular in shape and character, which latter condition is always the result of an attempt to produce a loud note by the energy of the touch, as when striking heavily the pianoforte keys, or employing too great a pressure of the bow on certain stringed instruments. And again, when making an overstrained effort of the breath whilst blowing into a wind instrument. In fact, there must be always a *time consumed* whilst creating an intense, and, consequently, a loud, clear note; as exemplified when playing on a musical-glass, the intonation from which is not fully brought forth by the heavy pressure of the finger on the vessel, nor is it the energy of the voice, but the *humouring* of the sonoro-electric fluid that breaks the glass when singing over it, the note elicited from striking it. Further, the hammers of the pianoforte should rest for a short period against the strings, if we wish when playing an effective adagio to produce a prolonged

intonation, making this instrument sing, as fine sensitive performers term it.

An instrumental musical tone is made up of the matter of sound, combined with a definite portion of electro-magnetic fluid. These are often combined with certain implemental noises, designated *timbre;* but when a melodious tone emanates from the human organisation, there is associated with it particular emotional expressions, and even the mental feelings of the being that gave birth to it, which qualities can even be conveyed by the telephone.

378. Sounds travel, whether diminutive or great, with equal periods in like media of the same temperature and density; producing effects according to their quality, or form, and sonoro-electric intensity, after the manner, as regards time, of falling bodies, as demonstrated with the feather and guinea when precipitated in *vacuo.*

379. Persons totally deaf—who therefore cannot be affected through the common organ of hearing—often receive *very great pleasure* from musical performances, by placing their hands on the chest of a person singing, and also by touching instruments which are being played upon. This well-known fact shows that the ear and its belongings *have nothing to do with the appreciation of melodious sounds;* it must therefore be the fibrillæ of the organ of *melody* that so charms us, when set in vibratile motion by musical tones.

380. A bar of soft iron, during the process of magnetization, often emits an audible sound (as does the wire when conducting a stream of electric fluid—see sec. 40) and becomes sensibly increased in length. It has also been noticed that all sounding bodies enlarge in size or expand whilst vibrating, which is exemplified by the breaking of the glass when its own proper note is sung into it. (See sec. 373.)

381. *Speaking trumpet.*—The loud noises produced by means of this instrument, do not depend upon any supposed repercussion of sound; repeated echoes might divide but could not augment the quantity of impulse. It is immaterial whether the trumpet be covered or lined with cloth, still the sound is of the same intenseness, so that it is not from being reflected from side to side: the impetus must occur then, owing to the sounds being prevented from spreading laterally, and therefore ability is required, allowing the voice to arouse into pulsatory action, and intensify the sonoro-electric fluid resident in the breath, and also the air of the trumpet, and thus the articu-

lated sounds burst forth with greater energy, and the undulations being as it were excited into vigorous operation, enable them to advance with greater vehemence through the atmosphere.

382. *Harmonics.*—By the harmonics of a musical note, are meant those tones in which the number of vibrations per second are twice, thrice, and four periods, or any multiple of the number of pulsations which produce the note in question. Thus the harmonics of a note which is sounded by 200 vibrations or waves per second, are those tones which require 400, 600, 800, &c., pulsatory waves per second. On the long strings of a pianoforte, as the fundamental note subsides, its harmonics may be perceived. It has often been observed among the vaulted roofs of a cathedral, several of the harmonics of the notes sounded whilst singing or chanting may be heard. Chords are said to be the language in which harmony expresses itself, and the laws whereby the one is governed likewise regulates the other.

383. *Æolian harp.*—If we take off all the strings but one from this instrument, we yet can often hear a variety of notes, and frequently such as are not produced by any aliquot part of the string. Often, too, there is heard a chord of two or three notes from the single string. This result was no doubt produced by the air striking different parts of the chord. First in the middle, which called into being the note of the whole string and its harmonics, and then before the chord quite recovered from the bulge produced by the first impulse, it was struck in a different part by a second stream of air, and this awoke another tone (and as undulations of sound do not interfere with each other, like the waves in water) different notes are heard with their harmonics. It is to these harmonic tones bursting forth from sounding instruments that notes owe much of their intensity and increased loudness.

384. *Beats* in music are the pulsations resulting from the joint vibrations of two sounds of the same strength, and nearly of the like pitch; that is, if two sounds differing but little in intensity, and which are almost, but not exactly, in unison. If we change the first string of a violoncello for another about as thick as the second chord of this instrument, and then screw this fresh string up until it approaches gradually to an unison with the proper second string of the violoncello in question, the sounds of the two chords will be heard to beat very quickly at first, then more slowly until at last they make an uniform consonance without any beats or undulations. At this juncture, either of

the strings struck alone, by the bow or finger, will excite large regular vibrations in the other, plainly visible, which show that the times of their single pulsations are equal. Thus the vibrating movement of a musical string puts other chords in motion, whose tension and quantity of matter dispose their undulations to keep time with the pulses of sound and air propagated from the string that is struck; a phenomenon explained by Galileo, who observes that a heavy pendulum may be put in motion by the least breath, provided the puffs be often repeated and keep time exactly with the first vibration of the pendulum. If we alter the tension of either of the strings in question a very little, the sounds of the two will beat again. But now the motion of one string struck alone makes the other only start, exciting no regular vibrations in it, a proof that the pulsations of the strings are not isochronous or in equal times.

In tuning unisons, as in the case of two or more pipes, or strings, the operator is guided by the beats. Until the unison is perfect, more or less of beating will be heard, as the sounds approach each other. When the unison is complete, no beats are discoverable; but if very defective—they have a result like a rattle. The complete absence of beats affords the best means of attaining a perfect harmony.

385. *Chord*, in music, is the harmonious combination of three or more musical sounds. The whole string when trembling gives forth the gravest, or generating, sound; four-fifths of the string give the major 3rd; two-thirds produce the perfect 5th; and one half, gives the octave. Thus is produced the perfect or common Chord, or triad (three united), which together with the chord of the seventh is the source of real cords.

386. *Sound-vibrations produced by caloric.*—If a heated poker be laid slantingly on a block of lead at the ordinary temperature, it will begin to vibrate, first slowly and then increase with such rapidity as to produce a prolonged note, which continues for a period, and at its termination sometimes changing to an octave. Here we have sonoro-electric effects produced by caloric, showing the intimate or reciprocal relation between sound, heat and electricy.

387. *Ventriloquism* (literally, belly-speaking) is a vocal mimicry of sounds, as the voices of different persons, expressions of animals, also those of musical instruments, and other sounds and noises. The capability of exercising this art, depends upon the copyist having a large organ of *Imitation*.

When this phrenological development is greatly augmented in an individual, we always find him capable of portraying the appearance of things, as the expression of countenances and gait or movements of certain persons, so as to call up to memory the ways of particular individuals.

388. *Sound can be conducted like electricity and galvanism.*—Thus sonorous pulses can be conveyed along rods of wood or metal, and given out at a long distance, as exemplified by the tuning-fork and strip of deal and the wire in the telephonic process. The undulatory vibrations from the forks, &c., call into action the *sonoro-electric* fluid resident in the wood and wire, &c., and it gathers energy as it progresses, and thus delivers the tones intensified as when conducted by the strip of wood into the instrument situated in the distant chamber, and from this latter into the more elastic medium, the air.

389. The Cicadæ (grass hoppers) of the Brazils, are audible at the distance of a mile. If this insect was as large as a man —all things being in proportion—it could be heard throughout the world. These creatures make their noises by day, the Fulgoræ (lantern-fly) at night. The drum of these animals is acted upon by muscles, for when these are pulled and suddenly let go, even in a dead specimen, the sound is produced as though the insect was alive. They act by drawing in and forcing out, by their alternate and rapid contraction, a horny *drum* or membrane, stretched in such a manner as to vibrate readily; the sound occasioned by the movements of which, passes out through an aperture resembling the sound-holes of a violin.

390. *Sound elicited by the action of galvanism.*—Whilst polarising an oblong bar of soft iron, with the galvanic fluid, it is found at first to produce a note, which is again repeated when the current is broken.

391. When a bell is rung in vacuo, no sound is heard, but if the bell be connected by means of a wire, with the air-pump plate, then the sonorous pulsations can be detected, because the metal like the air contains the matter of sound, and thus it can be awoke into audible action on entering the more elastic atmosphere.

392. *Interference of sonorous waves.*—Two streams of pulsatory sounds, when meeting, can cause silence, as two sets of luminous rays interfering with each other produce darkness, or as two waves annul each other upon water.

(*a.*) RECAPITULATIONS AND ADDENDA.—Sound, like light, may be reflected several times in succession, and as reflected light under these circumstances becomes lessened to the eye, so successive echoes are gradually enfeebled to the ear.

(*b.*) The velocity of sound in iron is seventeen times greater than in air, and in pine wood it has ten times the celerity which it has in the atmosphere.

(*c.*) In two strings of the same material, equally long and similarly stretched—if the one has twice the diameter of the other—the thinner chord will execute double the number of vibrations of its fellow in the same time.

(*d.*) Tyndall states that one sounding fork when vibrating, can incite another into motion, so as to give forth sound, the pendulum also of one clock when oscillating, will set another that is quiescent in motion.

(*e.*) In the labyrinth of the internal ear, is an organ, discovered by the Marchese Carti, which is to all appearance a musical instrument, with its chords so stretched as to accept vibrations of different periods, and transmit them to the nerve-filaments which traversed the organ. This natural lute is said to have three thousand strings, which convey the sounds and music of the outer world to the brain and thence—as regards musical undulations—onwards to the fibrillæ making up the organ of *Melody*.

(*f.*) If apertures be made in a sounding organ pipe, and a flame be applied opposite any of these holes bored in front of the ventral segments of the sonorous column of the pulsating air within the pipe, it will be blown out, but a burning taper is not disturbed when placed opposite the apertures made in front of the nodal points belonging to this aerial undulating column. (See section 40.)

(*g.*) When a tuning fork receives a blow and is then made to rest on a pianoforte during its vibrations, every string of the latter instrument, which, either by its natural length or spontaneous subdivisions, is capable of executing corresponding pulsations, and responds in a sympathetic note. The strings not in harmony remain silent and quiescent.

(*h.*) Insects can hum forth sounds by means of certain spiracles (breathing holes) after their wings are torn off.

(*i.*) Wooden rods, formed into a scale, may be played upon like the harp by applying resin to the fingers before stroking them.

(*j.*) An augmentation of density produces a diminution of the velocity of sound, but does not alter the pitch of a note.

(*k.*) Every flame passing through tubes, is *governed* by certain tones. The moment the musical scale reaches the note that affects the flame, it instantly bursts into song.

(*l.*) Sound would appear to belong to the same class of imponderable elemental entities as electricity, magnetism, heat, and light, &c. Thus sound can be (1) undulated, (2) reflected, (3) refracted, (4) deflected, (5) conducted, and is excited into action by (6) induction, is capable of (7) interference, and (8) polarisation. Sound is also found to be reciprocal with, or transmutable into, heat and electricity; and, like the latter, is incapable of disturbing, expanding, and even disrupting, certain solid bodies, the texture or composition of which is inefficient to withstand its vibratory action, when of a given intensity.

(*m.*) Sound can undulate, or burst out of one body and enter that of another; but it requires, like other imponderable principles, or their modifications, to have a medium—as solids, fluids, or gases—in, or upon, which to display its effects. It has generally been supposed that a given musical note depended *alone* upon the rapid repetition of a series of pulsations; but it will be found on more minute examination that the chief circumstance creating a given melodious tone, as before observed, depends upon the size of its semiovoid ventral segments, each note having a distinct *form*, both in the length and width, of the vibratory outline constituting these segments. For instance, the undulations making up the euphonous waves which are awoke into existence, and thrown off, either from a short or small string, are more limited in their outline than those emanating from a larger, or longer chord, so that the pulsatory waves generated or called into being from the treble strings, are not so lengthened, nor so much expanded laterally, as those ventral segments formed on the bass scale.

The oscillatory motion and beat, then, of a given note, are merely qualifications, being the result of certain percussions, or frictions, which are necessary for the sensible production and formation of the tone in question. I would here ask, as friction is one of the chief sources of electrical phenomena, may not sound be a modification of this all-effective fluid?

(*n.*) *Intensity of melodious rhythms.*—This quality, as before noticed, depends at *first* on the duration of the frictional pressure of the bow upon stringed instruments, and the blast of air through the hollows of other musical apparatus; and

secondly, on the smoothness and regularity described, or formed, by the outline of the ventral undulations produced by these operations. In addition, the intensity of a tone will be found likewise to depend on the quantity of regular ventral segments and nodes established, and also the number of harmonics bursting from the vibrating string, or hollow tube. (See sec. 40.)

It is well known, relative to the sounding chord of a bass, fiddle, or musical-glass, that if the amount of the friction of the bow, in the one case, and the pressure of the finger in the other, be variously, or gently, augmented and made persistent, it will increase the division of the nodes and ventral segments, and consequently there must be thrown off a greater plurality of harmonics, which latter are not distinctly appreciable by most persons, being with them swallowed up, as it were, into the main, or common fundamental note.

(*o*.) Sir J. Herschel states that the waves of sound, like those of light, in passing from a denser into a rarer medium undergo, at a certain acuteness of incidence, a total *refraction*.

(*p*.) Sound, like light, as previously remarked, is capable of *polarisation*. Thus, if a tuning-fork, held by the handle, be struck sharply, and whilst vibrating be placed against a sonorous substance, a musical tone is produced. But this sound is very unequally audible in different directions. If the axis of the fork, or the line to which it is symmetrical, be held upright about a foot from the ear, and it be turned round this axis whilst pulsating, at every quarter revolution the sound will become so faint as scarcely to be heard, whilst at the intermediate axis of rotation it is distinguished clear and strong. The audible situations lie in lines perpendicular and parallel to the flat faces of the trembling fork, the inaudible at 45 inclined to them.

(*q*.) *Interference of phonic waves.*—Exemplification that two loud sounds may be made to produce silence, as two strong lights can be caused to affect darkness. Thus, a tuning-fork being struck and held over a glass jar, produces one continued sound. Now, take two tuning-forks of a like note, and after fastening a circular piece of card on one of the prongs of each, put a little sealing-wax on one, to make it heavier than the other. On striking both, and holding them over the jar, there will be intervals of silence, and periods of sound. This arises from the fact that sounds proceed in waves, and the intervals

above mentioned are, according to the longer ventral segments, arising from one of the forks, as they overtake and interfere with the shorter vibratory waves emanating from the other. Thus, when strings, or pipes, are not in perfect unison, they produce by *interference* of oscillations, beats, or silent undulations and augmented ones, in every second, thus creating a rattling of the tone.

(*r.*) *Sound and electricity elicited by like processes.*—One of the chief sources of electrical excitement is friction, so also it is of sound; in fact attrition or rubbing and percussion, are almost the only fountains from which we can practically derive either regular or irregular phonics, to the former belong melodious *tones* to the latter *tuneless noises.*

If we take some glass tubes from five to seven feet long and from an inch to an inch and a half in diameter, and suspend them in equilibrium at their middle portions; on rubbing the surface of one half (thus throwing the extremities into opposite electrical states) in the direction of their lengths, with a piece of damp cloth, musical sounds, with their harmonics, will be elicited, the character of which will be more or less acute, according to the pressure of the frictional applications. If the same experiment be performed with lengthened rods of any shape or material, the same result will be noticed. When bars of wood are used, flannel coated with resin may be employed instead of moistened cloth. It is found that cylinders composed of the same material, will always emit *like notes*, provided they are of *similar lengths*, whatever be the depth, thickness or form of them, so that their longitude be considerable, as compared with their diameter. Further, *friction* of steam passing through tubes, can create tremendous electrical excitement, as witnessed by the result of the passage of condensed heated vapour through certain pipes, like those attached to that magnificent steam apparatus at the Polytecnic Institution. By means of this frictional agency, the enormous Leyden phial battery there constructed, is charged in a few seconds.

That intense sounds can also be generated by the affriction of steam, is evident from the piercing whistle brought into play by its agency in our railway engines. A similar cause may, in a degree, be said to produce the notes from the horn, for though the vigour of the breath is apparently weak, the surface—like that of the sound board of the pianoforte—is, large, thus the actions and reactions are greatly multiplied

which giving rise to electro-sonorous excitement, produces the resulting intensity of sound. Again, if tubes, varying in size, be held over a jet of steam, different musical tones will be produced, according to their diameters and length. Further, burning hydrogen gas, applied in the same way, calls forth similar phenomena. But here caloric as well as friction is an accompanying agent, for as with the cold lead and warm iron (see sec. v.), so is it with the hollow cylinders; their surfaces must vary in temperature, and are thus in opposite electrical states as regards heat.

(*s.*) *Electricity giving rise to sound.*—Faraday and Daniel have shown that phonic undulations are produced by the electrical-brush whilst playing on water, and most persons have heard the crackling effects of the electric fluid whilst passing through the air followed by rolling thunder.

(*t.*) *Galvanism producing sound.*—If we send a stream of the galvanic element through certain metallic bars so arranged as to tremble readily, they become increased in length and give forth musical notes. (See sec. 40).

(*u.*) *Sound acting after the manner of heat.*—La Place demonstrated, that heat is developed through every undulation by which sound is conveyed, and an electric-jar can be discharged if put into a vibrating state, as when sounding it like the harmonicon or musical glass.

The pulsations of sound cause bodies to expand by separating their molecules after the manner of heat, as noticed with the glass that is broken by the voice, the particles of the vessel are so separated as to overcome their cohesion. Professor Daniel states that when a string or chord vibrates, it becomes much lengthened, and that it would take two or three thousand pounds to stretch a rod equal to that produced by certain vibratory undulations passing through it.

(*v.*) *Heat generating sound.* (See sec. 214.)—If a heated poker or copper bar—as before noticed—be laid *slantingly* on a block of lead at the ordinary temperature, it will begin to vibrate, first slowly, but afterwards increase with great rapidity, and when the intensity is sufficient, and the undulations have assumed a certain form number of ventral segments, we obtain a musical note, which continues for a period, and then sometimes changing to an octave is accompanied with harmonics.

Here there will be found an electrical action between the warm and cold bodies; they both undulate rays of heat according to the state of their temperature, the one, perhaps,

acting positively, the other negatively (see sec. 40), for these vibrations never take place between substances of the same nature, electrical quality or temperature. The pulsatory waves are observed to originate with an intensity, proportional (within certain limits) to the difference of the conducting abilities of the metals for heat or electricity. In other words they are most intense when the heated metal is the best conductor, and the cold the worst.

(*w*.) The temperature of musical instruments alters them in their pitch, as observed after playing on a flute for a time; organ pipes vary considerably in winter and summer.

(*x*.) The statue of Memnon, at Thebes, sometimes emits sonorous undulations, like those of the æolian harp, when the morning beams of the sun play on one of its surfaces, which of course becomes more heated than the other. The sun rises in the east very rapidly, and of course instantly acts with great intensity, thus throwing the front and back of the statue into opposite electrical states, which lead to the phonic phenomena in question. About three leagues to the south of Tor, in the neighbourhood of Mount Sinai, are certain rocks called El Nakous, (Nakous is the name of a sonorous metal plate used in the Greek convents in the East instead of a bell) from the musical sounds of a very singular and surprising character being heard there. Mr. Sutzen and Mr. Gray, of Oxford, visited these localities with the worshipping pilgrims in 1812. These gentlemen describe the rocks as consisting of hard sandstone, covered with white and lightly adhering sand that readily peals off and slides down with the slightest touch, and also when the burning rays of the sun distroy its cohesion. That it was the gliding sand that produced the sound by its friction—they found—by detaching some of the fine scales in quantities; as these slid down the mountain, the phonic undulations were increased or lessened according to the quantity loosened. "The sound," says Mr. G., "appeared to have the greatest analogy to the humming-top; it rose and fell like the æolian harp sounding by the action of the wind upon it. To ascertain the truth of my discovery," continues Mr. G., "I climbed with the utmost difficulty to the highest rocks, then slid down, and endeavoured with my hands and feet to set the sand in motion. This produced an effect so great, and the sand rolling down called forth such a result, that the earth seemed to tremble, and I certainly should have been alarmed had I been ignorant of the cause." Mr. G. asks, "Does the rolling layer

of sand act like the fiddle-bow on the violin?" Here, again, the two sides of the rock were of different temperatures, and, of course, it was then in a condition to throw its innate electricity into a state of vibratory excitement, from the one surface (as regards heat) becoming negative and the other positive, the antecedents to the production of the melodious tones in question.

There are many rocks, and their fragments, in different parts of the world, that by percussion and friction produce melodious tones, as witnessed in the *Rock Harmonicon* constructed from pieces of stones procured from Cumberland, upon which used to be played, some years ago in London, with so much talent and effect, various concertos by the performers. There is a rock situated at St. Govan's Well, not far from Pembroke, which I have often struck and found it to give forth a clear musical, ringing note. Tradition relates that near this celebrated local wonder once stood a chapel, in which formerly hung a large silver bell. Some mariners are said to have landed on the coast in order to purloin this implement for its intrinsic value. The sailors having obtained it, were necessitated in their passage to the boat to rest the bell on the rock in question previously to putting it on board. This circumstance is the marvellous reason assigned by the near dwellers for the wonderful sonorous property possessed by the large block of stone in question. The ship, with its precious freight, it is gravely stated by the peasants, foundered not far from the shore as a judgment on the sacrilegious robbers. There is a large mass of stone, called the "Bell-rock," situated on Restall Common, near Tunbridge Wells, which, when struck sharply with a boy's bat, or hammer, gives forth a sound like a church bell.

Near the city of Hermosillo, in Mexico, is a vast hill, named *El Clerro de la Campana* (mountain of the bell), whose summit is crowned with enormous blocks of stone, which when struck render a very clear metallic sound.

(*y*.) The dispersed and general rays of light have been compared to the *noises* among sounds, so also may musical tones be collated with colours. For as each melodious note must consist of a definite number of pulsations or ventral segments, which always assume a certain ellipsoid outline or form, characteristic of that note, so also must every separate colour be made up of tinted undulations; these colour vibrations have necessarily assigned to them precise curved forms distinctive

of each hue, as it emanates from bodies, to wake up in us the sensation of colourization.

393. Voice (Latin *vox*).—Almost every animal has a voice or a cry peculiar to itself, originating in an apparatus adapted for that purpose, of more or less complexity. The voice is most perfect and varied in man and birds, but they differ extremely in degree as to this important gift. In quadrupeds and reptiles it is limited to a few uncouth screams, bellowings, croakings, &c., and other noises, whilst in many birds it assumes an approach to musical notes, and even articulate speech. Some birds and especially man, who have the phrenological organ of *Imitation* large, can mimic with the voice every imaginable kind of noise, and also utter musical notes of a sweetness and delicacy attainable by no instrument. But in all, without exception, (unless, perhaps, the chirp of the grasshopper, and cricket, &c., be one,) the sounds of the voice are produced by a *wind instrument*, acted upon through the column of air contained in the mouth, throat, and anterior part of the windpipe, set in vibration by the issue of a stream of breath from the lungs, through a membranous slit in a kind of valve placed in the throat. In many, as with quadrupeds, this organ is single, but in birds it is double; a valve of the kind, above mentioned, being placed at the opening of each of the two branches (bronchial tubes) into which the trachea (windpipe) divides itself as it enters the lungs, just before they unite into one common windpipe.

How, it may be asked, can tones of such gravity as we hear produced by the human voice, be excited in so short a column of air as that contained in the throat of a man? The vibrating column here is only a few inches in length, yet the notes produced by a bass singer are those which would require a pipe of several feet in length sounded in the usual manner, and must therefore depend upon the influence of the organ of *Melody*, directed by the soul's creative action.

394. From M. Savart's experiments it appears that in short pipes, and cavities whose other dimensions have a considerable ratio to their length, the tone yielded is rendered much graver when the pipe or cavity is constructed of a flexible material, capable of being agitated and set in vibration by the air, than when made of more rigid materials. He constructed a cubic box-pipe, with paper stretched on slight square frames of wood, joined together at the edges, and made it speak by an embouchure at the edge. He then observed, that so long as

the paper was tightly stretched the sound yielded by the cube was nearly as acute as it would have become had the whole been rigid, but that when its tension was diminished by exposing it to moist vapour, or even by wetting it, the sound descended in the scale by an interval proportioned to the degree of moisture the paper had imbibed. It was thus lowered even two whole octaves, when it grew so feeble as to be no longer audible; but repeating the experiment *in the stillness of night*, it could yet be heard, and no limit indeed then seemed set to the descent of the sound; and even when no longer audible, the pulsations of the paper sides could still be made sensible by sand strewed on them, which arranged itself in nodal lines, for the most part elliptic.

395. It is the friction of the breath acting on the air tubes and vocal chords—exciting into action the animal electricity, thus creating or calling into operation the sonoro-electric fluid—that educes the pulsating tones and noises that living creatures give forth, announcing their presence, and thereby creating sometimes pleasure, or it may be alarm, and even terror. At other periods these organs—when appertaining to the human race—can fascinate, by giving rise to *special* melodious notes, which sometimes call forth particular *sympathetic* feelings as they pervade sensitive educated systems, whilst listening to certain tuneful and harmonious voices, as they are being exercised near our persons. Further, these musical airs are also found capable of waking up distinct and reverberating echoes with their harmonics, even in the domes of large buildings. They who have listened to the lion's astounding roar in the forest of a stilly night, or at a like period, heard the frightful vociferations of the distant howling monkeys of the South American woods, can alone be conscious of the tremendous abilities of the vocal organs of animals.

396. The voice is more sonorous in cold and dry, than in moist and warm weather. This results, first, from the dense atmosphere being more capable of frictional action on the air passages. The voice becomes very shrill and weak, when the lungs are filled with watery vapour, and especially with hydrogen gas. Secondly, sound travels with three times the velocity in hydrogen to what it does in air; on account of not meeting with the obstruction necessary to create its full development, for it is found that sonorous pulses—like electric undulations—become more effective in their sensible results, as the medium to their transmission offers resistance. Hence

we hear much further through cold dry air than in a damp atmosphere, though not so rapidly.

397. In blowing into the trachea of a dead person, why does it not produce a sound like that of the human voice? Why is the palsied state of the internal muscles, &c., of this organ followed by the loss of voice? Why in a word is an *act of the will* necessary to produce a proper or natural vocal sound? It is because the ligaments of the glottis (the superior opening of the larynx or windpipe) have not the faculty of vibrating, except the thyro-arytænoid muscles of the larynx are contracted, which takes place under the influence of the nerves that are governed—especially in man—by the mind acting primarily upon the brain.

Experiments performed on animals, are perfectly in unison with this doctrine as regards the nervous system, for if we divide the two recurrent nerves—that act on the larynx—the voice cannot be exercised. If one nerve is cut, the voice will be only half lost. M. Magendie, however, heard a number of animals, in which the two recurrent nerves had been cut, cry very loudly when they suffered severe pain. These sounds were not governed by the life-principle of these animals, but were similar to the intonations that would be produced mechanically with the larynx of the creature when dead, by blowing into the trachea (windpipe) and bringing together the arytænoid cartilages.

(*a*.) *Tone of the voice.*—Every individual has a particular utterance by which he is known; there is also a distinct intonation belonging to eunuchs, the different sexes and also age. The sound of the voice presents an infinite number of modifications, depending on organization and education. The auditory apparatus of man, is an instrument of most exquisitely musical and sound appreciating complexity. The human ear contains a series of minute bodies called the "rods of Corti," from the name of their discoverer. When a sound is communicated to the ear, first the auricle catches it up, and transmits it to the drum, which passes it by vibration through the middle to the internal portion of the organ. Here it is appreciated merely as a sound, its direction and volume being also recorded; but to distinguish a musical note, it is passed into the cochlea, a *spiral canal*, from the axis of which proceeds a very small plate of bone; this in turn gives out two membranes, and between these lie the "rods of Corti." Looked at from above, they resemble a double row of pianoforte

hammers; but the outer rods as they wind up the spiral axis, increase in length more rapidly than the inner, whereas the latter augment in number, so that near the apex the outer rods are twice as long as the inner, while to 3,500 outer rods it is computed that there are 5,200 inner ones. Under this delicate and perfect sounding-board, are clustered nerves and nerve-cells, which serve to bear the impression of any vibrating rod or rods to the brain; and with so vast a keyboard, it is plain that not merely semitones, but tenths and even fiftieths of tones or vibrations in sounds, must be recognised by this consummate recording apparatus. It is upon the lamina spiralis, then, or minute plate of bone, before mentioned, that the sound is thrown in order to decide its note, and however fine or faint, that sound discovers some one of these rods which will leap into vibration in concert with the impulse, and send a melodic or harmonic telegram to the sensorium.

(*b.*) A musical tone, when effectually qualified and formed, is doubtless made up of the matter of sound and the elements of electricity, heat and magnetism, &c., and mostly has also pervading it, the timbre of the instrument from which it was evoked; but when the note emanates from the human vocal ograns, it will then be found to have clinging to it, the emotional feelings, &c., of the person that at the time called it forth. All these melodious qualities and properties can be appreciated at their birth, by a perfect and educated organization.

(*c.*) The voice, whether it be or be not united with verbal speech is expressive of the sensibilities, in fact the voice is the language of the feelings, by which they often manifest themselves to the ear without previous teaching. The scream of terror, the shout of joy, the laugh of satisfaction, the sarcasm of ridicule, are made by man and understood by his fellow creatures, wherever the one may be born and whatever may be the speech of the other. The voice is a natural and universal language. Each mental attribute has its voice, which is in relation to that quality; and whether that attribute forms part or rather an emanation of the mind of man, or the life principal of the brute, it instantly recognises the voice. The piercing cry of pain, the affrightening vociferation, and the happy expression of pleasure, are common to all and recognised by each.

(*d.*) A legitimate musical tone must be idealised or suggested by the mind in the *human brain*, which, by exciting—through the agency of the nervous system—certain muscles to act on

the larynx, throat and mouth, &c., regulate and govern the voice, that further under the influence of the organ of *melody*, can give forth the very varied harmonious notes we sometimes listen to with such exquisite pleasure.

(*e*.) The whole compass of the human voice, from the lowest of the bass to the highest of the soprano is nearly four octaves. The voices of children resemble very nearly those of women, but in males, a remarkable change takes place at puberty, when the voice is said to crack; the change from the shrill treble voice of the boy to the fuller tone of the man, is sometimes perfected almost suddenly; but in most cases it is for some time in progress, wavering between the two extremes, that is deep and manly during quiet enunciation, but when any exertion is used, suddenly starting up again to the shrill tones of boyhood (these youthful results as regards the condition of the male voice, are owing to the changing condition in the economy of the cerebellum or small brain). In old age, the cartilages of the larynx (upper part of the windpipe) becoming bony, the ligaments hard and unyielding, and its muscles pale and powerless, with sometimes softening of the brain, the voice completely alters; it trembles as if there were not sufficient strength in the muscles to maintain a due tension of the vocal ligaments it becomes harsh and monotonous.

"Turning again towards childish treble,
Pipes and whistles in the sound."

(*f*.) In all air-breathing vertebrata (animal with spine bones) the production of sound depends upon the passage of air through a certain portion of the respiratory tubes; which are constructed so as to set it in vibration, as it passes forth from the lungs. In reptiles the breathing apparatus is situated at the point, where the windpipe opens into the front of the pharynx (upper part of the gullet), being only composed of a slit bounded by two contractile lips, and these animals are found only to hiss or croak. In birds the windpipe opens into the front of the pharynx, as in reptiles, by a mere slit; the borders of which have no other movement than that of approaching one another, so as to close the aperture when necessary. The *vocal* larynx of the feathered tribes is situated at the lower extremity of the windpipe, just where it subdivides into the bronchial tubes. In mammalia (animals with breasts) on the other hand, the vocal organ and the regulator of the respiration are united in the larynx, which is situated at the top of the windpipe.

(*g.*) The *loudness* of the voice depends in part upon the vehemence with which the air is expelled from the lungs; but the variations in this respect, which exist among different individuals, seem partly due to the degree in which its resonance is increased by the vibration of other parts of the larynx, and the neighbouring cavities. In the howling monkey of America, there are several pouches opening from the larynx, which seem destined to increase the volume of the tone that issues from it; one of these is excavated in the substance of the hyoid bone of the throat itself. Although these monkeys are of inconsiderable size, yet their voices are louder than the roaring of lions, and are distinctly audible at a distance of two miles; and when a number of them are congregated together, the effect is terrific.

(*h.*) The ability of producing *articulate* sounds, from the combination of which speech results, is said to be altogether independent of the larynx, being due to the action of the muscles of the mouth, tongue, and palate—yet the bird, minus part of these, can utter clear words. Again, distinctly articulate sounds may be produced without any vocal or laryngial tone, as when we *whisper*; the only condition necessary for this mode of speech is the propulsion of a current of air through the mouth. On the other hand, we may have the most perfect laryngeal tone without any articulation, as in the production of musical sounds, not connected with words.

(*i.*) It was once observed by a witty musician, "that a man with a musical soul could elicit imitative melodious tones from a bootjack." I myself can image, and call up before the listener, without using the larynx or breath, any tune that may occupy my mind, merely by tapping with the fingers my cheeks, and at the same time regulating the sound produced by employing the muscles of the mouth to enlarge or lessen its dimensions. A friend of Mr. Cleaverly could, in the same way, imitate the cantering of a horse. I recollect, as do many others, the period when Van Joel (who was called the "chin chopper") used to play the overture to Lodoiska, &c., at Vauxhall Gardens, by striking his lips and chin with his knuckles. My brother could play any tune upon the pipe of a common bellows.

(*j.*) The dog may be trained not only to know the meaning of words, but to speak them. Leibnitz reported to the French Academy that he had seen a dog in Germany which had been taught to pronounce certain words. The teacher of the animal

was a Saxon peasant boy, who having observed in the dog's voice an indistinct resemblance to various sounds of the human articulation, was prompted to make him speak. In three years the boy had taught his canine pupil to pronounce 30 German words. This dog used to astonish its visitors by calling, when prompted, for tea, coffee, chocolate, &c.—(Chambers' "Anecdotes of Dogs.") A friend of mine—Dr. Moss—was acquainted with a gentleman who had taught his dog to pronounce certain consecutive words. It would on occasions receive his master's visitors, and then announce to them the seat they were to occupy.

Voice of insects.—Many insects have the ability of expressing their passions, as fear, anger, sorrow, joy, or love, by the sounds they can generate. The most curious of these, given out under the influence of *alarm*, is that produced by the sphinx—(Atropes or death's-head hawk-moth)—which when confined or taken in the hand, sends forth strong sharp cries. The influence of anger, sorrow, joy, &c., is heard in the different hums of bees.—(Carpenter's "Animal Phy.," p. 504).

(*k*.) The French are said to speak as if from the nose, the Germans out of the throat, and the English through the teeth.

(*l*.) We cannot *voluntarily* utter a given sound or tone, without in the first instance conceiving it (however transiently) in our minds. But an *emotional* cry is performed by the mere instinctive tendency.—(Medical Review, v. 31, p. 165).

398. *The effects of music.*—Dr. Beattie observes that as the organ shakes the floor and pews of the church, and causes musical instruments to murmer by *reaction*, it must particularly affect the finer fibres of the human frame, (especially those of the nervous system, and most particularly the loops making up the organ of *Melody*), which are put in a tremulous motion, when they happen to be in unison with any notes proceeding from external objects. Most persons must have witnessed the effects of a street organ on certain dogs, apparently willing auditors, who, if not driven away, continue to howl all the while the instrument is playing. Dr. Mead tells us that a celebrated violinist of his acquaintance perceiving that his dog betrayed symptoms of great suffering on hearing a *certain passage* performed, repeated it for some time in order to try the result, and the experiment proved fatal to the poor animal, who dropped down at the feet of his master, where in a few seconds he died in convulsions. I am acquainted with a Mr. Streetfield

who has in his possession a little rough terrier, that when his mistress is playing certain airs on the pianoforte, becomes restless and very uneasy, and then of a sudden bursts into a distressing mournful cry, but when other particular pieces of music are evoked from this instrument by the same lady, the canine listener pays great attention to the strains, and appears as if pleased with the performances. I may also mention that if this animal hears the notes of a concertina, even in the distance, he appears to be enraged, and rushes about as if wildly distressed.

(*a*.) Association, which has so large a share in the operation of the mind, often contributes much to the effect of music. Some airs, possessing no intrinsic merit, owe their influence solely to this principle, and among these the famous *Rans des Vaches*, which, in times happily gone by, acted with such irresistible effect on the expatriated Swiss soldiers, as did the screeching, discordant, and droning semitoned bagpipes on the Scotch troops when on foreign service. In fact, music often pleasurably, and sometimes painfully, wake up former personal circumstances.

(*b*.) Colonel Briggs relates that he has seen the *naia tripudians*, a species of aspis, or viper, very venomous and active, come out of their holes in the temples of India, when a pipe has been played to them, and feed out of the hand as tamely as any domesticated animal; and it is when in this state of docility, so opposite to their shy but impetuous nature, that the Hindoos believe that their deity has adopted that form.

(*c*.) The *cobra capello*, or hooded snakes of India, have a great fondness for music. Even when recently caught they seem to listen as if fascinated by the notes, and are even seen to writhe themselves into strange attitudes. The native jugglers improve greatly on this instinct, and, after taming, by degrees instruct them even to keep time to their flageolet.

(*d*.) To most persons the more complicated combination of a *third* of the fundamental note is more agreeable than the less intricate one of the *fifth*. People in general require a certain education before they can appreciate the *minor key*, or *discords*. It may be observed that the intervals of the minor third and minor sixth have a sad, or at least plaintive effect, as compared with the major third and major sixth of the diatonic scale. The change from the minor to the major scale is perhaps the most effective of musical resources; certainly the

most appreciated and understood by persons of the ordinary degree of cultivation.

(*e.*) The epidemic, *tarantismus*, a kind of St. Vitus's dance, said to be the result of the bite of the tarantula spider, which occurred in Naples in the 16th century, was supposed to be cured by music, and its phases become altered in character according to the strains performed.

(*f.*) Music to some individuals is a language, or a dialect, expressed by melodious tones; and in addition to calling forth feelings, it is capable of conveying, and also of giving rise to happy, or it may be, sad ideas. The sooty blackbird, through his mellow pipe, warbles forth imitative musical notes to his mate, thus sustaining her incubative efforts as she nestles in her shaded bill-formed home, wherein rests the source of her loving cares—the envelopes of her future progeny. Again, the fond mother, or affectionate nurse, often sings or hums to the younger branches of the family a soothing lullaby, in order to tranquillise or hush them into sleep.

(*g.*) Ælian, writing concerning the Roman elephants, states that particular attention was directed to the effect of music upon them; and they were so accustomed to sounding instruments, that they not only lost all dread of the clashing of cymbals, but learnt to feel delight at the gentle notes of flutes, and would beat time with the feet when their feelings were gratified with the agreeable notes to which they were habituated.

(*h.*) Mr. Cross's elephant used to throw forward her ears as the guards marched from the adjoining barracks, to listen to the notes of the band, and the motions of her restless body were often adapted to the movement of the airs executed. Sir E. Home had a pianoforte sent to Exeter Change to watch the effects of acute and grave sounds upon the elephant. The treble notes seemed hardly to attract his notice, but as soon as the grave bass chords were struck, he became all attention, brought forward his ears, tried to discover where the sounds came from, remained in the attitude of listening, and, after some time, made noises, the result, it appeared, of being much pleased. Suetonius tells us that the Emperor Domitian had a troop of elephants disciplined to dance to the sound of music. Outrageous bulls have in several instances been calmed into gentleness by music. Even fishes, upon better authority than the story of Amphian and the dolphin, according to Dr. Southey, have shown signs of being affected by music, as

where the sirene (a musical instrument that can be performed upon when situated in a fluid element as well as in the air), has been played upon under the water, and seals have been seen to crowd forward to hear the violin. "Seals," says Valerius Flaccus, "delight in song," which Sir W. Scott has rendered,—

> "Rude Heiskar's seals, through surges dark,
> Will long pursue the minstrels bark."

(*i.*) Madame Piozzi gives an account of a tame pigeon which answered by gesticulation to every note. As soon as she began to play the bird hurried to the instrument with every indication of rapturous delight. A false note produced in the pigeon evident tokens of displeasure, and if frequently repeated, it lost its temper and tore her hands.

Lockman relates that he knew a pigeon that always came to the window from the dove-cot when a young lady was singing a certain air, and on the song being finished, returned to its usual abode.

(*j.*) In Germany they take the shad (alosa clupea) by means of nets, to which bows of wood, hung with a number of bells are attached in such a manner as to chime in harmony when the nets are moved. The shad, when once attracted by the sound, will not attempt to escape while the bells continue to ring.

(*k.*) An officer, confined in the Bastile, begged its governor to permit him the use of his lute to soften his confinement by the harmonies of his instrument. At the end of a few days this modern Orpheus, playing on his musical implement, was greatly astonished to see bursting out of their holes numbers of mice, and descending from their woven habitations crowds of spiders, which formed a circle about him, while he continued to play. At first he was petrified with astonishment, when, having ceased to play, the assembly of animals immediately broke up. Having a great antipathy to vermin, he allowed two days to pass before he ventured to touch his lute; but having mustered up courage to conquer his dislike, he re-commenced his concert, when the assembly was by far more numerous than at first; and in the course of further time he found himself surrounded by hundreds of these animal amateurs.

(*l.*) Mrs. S. C. Hall, of Kensington, possessed an Italian greyhound which screamed in apparent agony when jarring combinations of notes were produced, either accidentally or

intentionally on the pianoforte. A gentleman of Darmstadt once taught a poodle dog to detect false notes, which always produced a yell from her, forming a most expressive commentary upon the misperformance.

(*m.*) A French author states that at the beginning of the Revolution there was a dog in Paris known by the name of "Parade," because he always attended the military parades. He continually stood by and marched with the band, and at night went to the Opera, Comedie Italienne, or Theatre Feydou, dined with any musician who expressed by word or gesture that his company was asked, yet always withdrew from attempts to be made the property of any one.

(*n.*) "When I hear beautiful music," observes the author of 'Selborne,' "I am haunted with passages therefrom night and day, and especially on first waking, which by their importunity, they give me more regret than pleasure." "After hearing the human voice," relates another author, "there was left in my mind a certain continual agitation, disturbing attention and sleep, while the risings and fallings, the tones and changes of sound and concords, pass and repass through the imagination."

Alfieri thus speaks of the first opera he heard when only twelve years of age:—"This varied and enchanting music sank deeply into my soul, and made the most astonishing impression on my fancy; it agitated my feelings to such a degree that for several weeks I experienced the most profound melancholy, which was not unattended with pleasure. These effects long remained engraved on my sympathetic spirit." Further, he observes, "On returning from the performance of a piece I have not heard for some time, it acts energetically on my mind as do all species of music, and particularly the sound of the *female voice*, and of contralto (the part immediately below the treble). A thousand gloomy and mournful ideas assailed my imagination, in which I delighted to indulge by wandering *alone* on the shores of the Chiaja Portici.

(*o.*) *Extraordinary display of musical ability in the mesmeric sleep.*—Dr. Braid, of Manchester, once invited Jenny Lind and some of her friends to a *séance* at his house to witness certain astonishing phenomena as regards musical capabilities in the magnetic sleep-state. There were two of the doctor's patients present who were employed in a warehouse of the above city. Dr. Braid having thrown by certain manipulations these personages into the artificial somnambulistic state,

sat down to the pianoforte, and the moment he began playing both sleep-wakers arose and approached the instrument, and there joined him in a trio. Having awoke one of the girls, Dr. Braid stated that although her sleeping companion was ignorant of the grammar of her own language awake, that when in the clairvoyant state she would prove herself competent to accompany any one present in singing in any language, giving both notes and words correctly. A Mr. Schwabe being of the company sat down to the pianoforte, and played and sang a German song in which the somnambule accompanied him correctly, giving both notes and words simultaneously with Mr. Schwabe. Another gentleman tried the patient in Swedish, in which she also succeeded. Next Jenny Lind sat down to the instrument and played and sang a slow air with Swedish words, in which the magnetic sleeper accompanied her in the most perfect manner. Jenny now entered upon the most difficult roulades and cadenzas, including some of her extraordinary *sostenuto* notes, with all the inflections from *pianissimo to forte crescendo*, and again diminished to the softest pianissimo, but in all these fantastic tricks and displays of genius, even to the shake, she was so closely and accurately tracked by the sleeper, that several in the room occasionally could not have told, merely by hearing, that there were two individuals singing, so instantaneously did the somnambule catch the notes, and so perfectly did their voices blend. Dr. Braid then told Jenny that the sleeper might be tested in some other language, when Jenny commenced "Casta Diva,' &c., in which the fidelity of the somnambulist's performance, both in words and music, was most perfect. Mr. Schwabe also tried her by the most difficult combinations of sound, which he said he knew no one was capable of imitating correctly without much practice; but the sleep-waker uttered them correctly at once. When the girl was aroused from her sleep, she had no recollection of anything which had been done, or that she had afforded so high a gratification to all present by proving the wonderful musical ability of imitation which are displayed by some patients during the state of artificial somnambulism: she stated when awake that she merely felt out of breath as if she had been running.

(*p.*) *Display of wonderful imitative ability of musical instruments and voices by a natural somnambule.*—A girl, aged seven, an orphan, of the lowest rank, residing in the house of a farmer, was accustomed to sleep in an apartment separated by a thin

system, strongly indicated in his countenance and figure, seem to have been the sources of his attaining this high degree of ability. Until a being constituted like Paganini appeared, one had no means of discovering what exquisite sounds and compositions might be called forth from material substances composing a violin and bow. In fact this world may be full of celestial qualities as well as delicious harmonies, if we had only superiorly organised men and women to bring them into evident existence.—(Combe's "Constitution," p. 84.)

(*v*.) History reports that in ancient times the notes were letters placed over the syllables, but Guido d'Arezzo, in 1100, invented the gamut, and musical notation. Luther was the inventor of metrical psalmody in 1517. The old hundreth was originally a love-ditty.

(*w*.) Musically speaking—England, says Gardiner, has never produced an original idea. He ascribes the thoughts of Purcell and Arne to Italians, and our grave church music to the Flemings. Melody belongs to ideality, and the feeling it creates appertain to Nature; harmony is more the result of scientific combination and is a work of artificial and modern discovery. The combining simultaneous sound affords the intellectual enjoyment of a succession of proper chords, only to be felt and estimated by the instructed.

(*x*.) The lyre of the Greeks was the harp of the moderns; and the viol and vielle of the middle ages is the prototype of the present violin.

(*y*.) On playing the hand organ to one of the Esquimaux, the first note made him grin horribly, this was followed by a yell, and a leap into the air, as if possessed by a devil, and he continued to jump and howl, using frantic gesticulation, until in mercy to the poor creature we stopped the organ and his ecstacies together.—(Kennedy in search of Sir J. Franklin.)

(*z*.) "I have constantly noticed," remarks Dr. Gregory in his letters, page 100, "that the magnetised somnambule is strangely affected by music. All the subjects," continues the Dr., "on whom I have seen it tried, have been most pleasantly influenced by it. Their features brighten up, and they usually assume attitudes and gestures corresponding to the character of the music. Thus a reel or a quadrille would set them dancing, and those endowed with fine temperaments do so with exquisite grace, while the clownish individuals sometimes stump about with much vigour, but little grace; these results occur in persons of both sexes, who had never been taught to dance,

except from Nature. A solemn strain made them join in devotional music. A warlike air caused some of them to march and strut about. All this will take place, more or less, in persons who have in their ordinary state no love or little care for music. A strain of soft harmony often assists in producing the mesmeric sleep in new subjects. This result agrees with the recorded fact, that music has always formed a part of the magician's arrangements. Again, when the sorcerer wished to cause those who consulted him to see visions, that is, to become somnambules, he always employed gentle harmonious airs and fumigations.

(*aa.*) When sleeping—especially towards morning—with the side of my head resting on the pillow, thus exciting into action the phrenological organs of *Ideality*, *Melody*, and *Time*, I myself often conceive or rather hear and feel most exquisite music, unlike any compositions I have ever previously listened to, and they at the moment appear as new to me, as did those of Paganini, when I first heard his soul-stirring original airs. I would likewise mention, that at periods whilst reposing, I hear a single female voice or a chorus executed by ladies, whose strains are always more melodious and fascinating than those of men. Further, I feel perfectly assured that I could, when awake, place this dream-music on paper, if I had an ability like that of Mozart, who always heard his most effective pieces in his sleep, which on waking from, he wrote down. I am impressed here to ask how the above results come about or transpire. We are mostly led to positively conclude, that all mental perceptions of new and distinct things, with their attached qualities and belongings, must have an origin from without. This being the case, I am often tempted to conclude that certain shadowless beings of the air impress the results in question on my organization, and through it on my inner self-hood.

ELASTICITY.

399. Elasticity (gr. *elaste*, a spring). This is one of those words which is *supposed* to represent a particular quality or natural energy, appertaining to certain bodies, but as at present employed—like the terms *power* and *force*—(see "Resistance," sec. 413), suggests to the senses no interpretation as to a direct or positive cause working out a sequence or effect.

(*a.*) The above negative appellations, so often applied to particular economies, are frequently received by the unreflective as explanatory of how certain results originate in the processes of Nature. Therefore my chief object in this disquisition will be to seek for the true causes or circumstances under which the property of elasticity is developed.

(*b.*) The term elasticity (see secs. 86 and 409) is generally applied to that property of matter where the molecules, after being partly separated by an external appliance, can regain their original position; but the distance created between them must fall short of fracture in some bodies, and also, minus that displacement with others, which would carry them beyond the bounds of their capability to recover by reaction, their former situation.

(*c.*) Some authors define elasticity to be an attribute, or propensity, which appertains to certain bodies of recovering their previous form and dimensions, after the external means by which they may have been dilated, compressed, or bent, is withdrawn; other persons have suggested that when the form of a body is affected by the pressure or action of another extraneous to it, the reacting ability by which it sustains, or tends to remove that pressure, is its elasticity.

(*d.*) But what is this reactive ability? Whence its origin? What is it that operates, and after what mode is the action brought about? Is it heat, electricity, magnetism, or condensed—so to speak—motion, or are all of these called into effective operation by the bent spring's effort to recover again by reaction that condition stamped upon it by Nature's arrangement of its qualified particles?

(*e*.) It has been considered, further, by certain essayists on this subject, that all ponderable matter is composed of indefinitely small parts, or corpuscles, acted upon by what has been designated *attractive* and *repulsive* energies. "The attractive energies," say they, "result from the action of the molecules on each other; the repulsive vigours result from the caloric with which the atoms are surrounded, or combined, and when bodies are in a state of *apparent rest*, these two antagonistic energies are opposite and equal."

(*f*.) It would appear to me that the molecules of matter are held together by other agents, or after a different mode to that commonly supposed. For instance, a piece of lime is in general merely regarded as being composed of oxygen and the metal calcium; but it should be remembered that all substantive entities are intimately combined with certain imponderable elements, as heat, light, magnetism, electricity, &c., and if we entirely extracted but one of these principles from among any of the materials surrounding us, they would lose or have all their present qualities altered, and consequently would then not be recognisable by our senses. It is by and through the constituents and properties of things that we appreciate or are capable of observing and notifying their being, or existence, so that the piece of lime in question must have entering into its composition heat, light, electricity, and even the matter of sound, &c., in order to constitute or give it the characters by which we apprehend it.

(*g*.) The imponderable principle, electricity, has been called pyrogen (fire generator) by Mr. Lake, who proved by many and varied experiments that this element has a positive material substantive and chemical character. It has been thought by some persons that this fluid principle, under certain circumstances, is capable of being transmuted into, or very intimately associated with, light, heat, and even sound, &c., as economy may require. Now, this so-called pyrogen exists under two states. First, in a static condition, as where it is imprisoned, and forms part of the constituents of bodies, and most probably by its presence renders each corpuscle vividly *electropolar*, thus holding them together. In this way the particles serve as fulcra (levers), so to speak, whereby the positive and negative form or state of pyrogen, can act and react on them; as the quantity or quality of this pyrogenetic or electric fluid of composition varies in substances, it may be the cause, perhaps, of rendering them hard or soft, &c. The

second state of electricity, or pyrogen, is that of being in motion; in this latter condition it will be constantly found passing (when not isolated) over the surfaces of all bodies, exciting forth the necessary changes in living and dead matter, and by its influences promoting the economy required by each entity. From the foregoing suppositions it may, I think, be granted, as before suggested, that heat and electricity, &c., enter into the composition of every substantive thing in existence. In fact, it may be stated that they form a most indispensable part of all bodies, and that without their presence, materiality, as now recognised, would become a nullity.

(*h*.) As heat has been *supposed* to be one of the agents keeping the corpuscles of the substantive world separate from each other, may not electricity, under polar attraction, serve to bind them together?

(*i*.) I consider that the property termed elasticity, is due to an action chiefly excited in and among those molecules which are confined to the surface of things, where predominates the agency of ever-acting inducting electricity. This so-called elasticity is particularly demonstrated when essaying upon elongated solid substances by procuring thin slices of them, unless we employ very long bodies which is only a multiple of superficial effects; and where the particles, or their associated elements, can offer but little resistance to the applied stress.

(*j*.) I conceive that on bending certain materials, the molecules on the concave, or opposite side to that put on the stretch, are driven closer together, thus squeezing out, as it were, the *heat of composition*, which was latent to our senses when forming a part of the substance under its natural configuration, but became free, or developed caloric during our operation, and could have been detected, if not by the hand, through Melloni's battery. By thus condensing, or causing the corpuscles to approximate each other, we increase their capacity of receiving back again the heat of composition, or its equivalent, that was expelled by our experiment; and, of course, on ceasing the effort that effected the curve, or bend, the disengaged caloric rushes in again, and acts like so many myriads of spiritous wedges—so to speak—which serve to force these compressed atoms asunder, and thus the body in question regains its original, or natural form and position. By means of strong pressure, or through certain percussions, the first

effort produces the greatest heat and change in density; thus, in coining copper of 8·85, the first stroke renders it 8·89, with an increase of caloric equal to 10 degrees; but the second blow makes it only 8·91, with an increment of 4 degrees of heat.

(*k.*) Heat acts differently on solids—as far as regards their so called elasticity—to what it does on fluids and gases, for on applying heat to dense bodies—so long as the temperature is below a certain point with metals, and short of destroying inorganized matter, their fibrous formation—experiment shows that there is scarcely any change in their elastic tendency; but not so with fluids and gases; the elastic ability of these latter being readily multiplied, with every increment of heat; so that solid substances are bound together by different conditions to those of fluids, vapours and gases, which can be attributed no doubt to the presence in their composition of more or less magnetism, electricity, and the matter of heat, &c., &c.

(*l.*) It becomes a question whether what has been called elasticity, or that reactive effort, resulting from the use of weight, leverage, or muscular exertion, as applied to certain actions on bodies, can in any way be associated with the collision of two free substances against each other. It is true that both are a consequence of motility, but the latter is a sequent of free motion, as far as the impact of the materials are concerned, and is cut off at the time of contact from the energy that originated the impetus, but not so with the former, here the body acted upon, though preceded by motion, is not free to return instantaneously, by reaction, to its original position, as was the case from collision. The effect produced by pressure on the body in question, is still in connection with it during the time of operation and unlike that after percussion, remains under command. Further, with oblong solids, the chief displacement of the molecules take place in the parts most remote from the applied energy, as where we flex a piece of whalebone, by making the two terminations approach each other, or by bending one end of a steel spring, whose other extremity is fixed. The reverse of this is the case in collision; here the dislodgement, if any, of the particles occurs directly opposite to the locality where the agency was applied. Again, the effects or operations producible by each are very different in character. Those resulting from percussion can be made to vary in every degree of intensity, whilst those

originating from pressure show an energy more circumscribed and consequently less effective. Thus, the stroke of the hammer, will exercise an ability upon the head of the nail, &c., which bare weight, however exercised, could never produce.

(*m.*) The quality of elasticity is stated by some authors to be intimately connected with that of hardness and brittleness, so much so, that it has sometimes been held that one character is proportional to the other. The foregoing observation had its origin from contemplating the effect produced by the impaction of certain *spherical* bodies, and is dated upon the *supposed* giving way and springing back again of their component parts. This action of yielding and restoring its surface in a body after percussion, appears to me to be most erroneous; and I am led by various facts—to be hereafter discussed—to attribute the cause of the recoil of spherical bodies after impact, to an electro-reactive energy. (See "Collision," sec. 410.)

(*n.*) When testing certain elongated bodies, for the purpose of demonstrating the quality of elasticity by flexion, we find varying results. Thus, contrast the action of strips of glass or ivory, with those made of whalebone or steel. If this yielding of a substance (which is represented as decidedly essential in order to constitute and display elasticity) was a property that could be effected by gravitating matter, independently of, or unaided by the imponderable elements; it ought to exhibit the same characteristics under whatever *shape* we find it, and the result should be identical, whether essaying with a strip of ivory or the same material made into a ball, since *form* can add no innate natural quality to ponderable bodies.

(*o.*) If we bend the free extremity of a spring, whose opposite termination is fixed, and place on the depressed end a ball, and then suddenly let go or remove the pressure that bore it down, the spring by this proceeding recovers the ability to react, and the sphere is then seen to suddenly start upwards to a given distance, through, as it is generally stated, an elastic ability. Now if we take an unyeilding piece of iron or wood —depositing on one end of the same the ball in question, and then equipoise the bar, so loaded, over the edge of some perpendicular material, we shall, on striking with a hammer the opposite extremity to that on which the sphere is placed—see the ball fly upwards ten times higher than it did by means of the previous experiment. Now this latter effect was not the result of what has been called elasticity, but was brought about through the animal electro-magnetic energy, appertaining to

the operator, which was ejected from his body and conveyed by the hand and hammer to the bar-lever, and through it to the globe.

400. *Collision, impact or percussion.*—It has generally been held by authors, that if two perfectly *inelastic* balls move towards each other in opposite directions and with velocities inversely proportional to their weights or masses, they will destroy each other's velocities and remain at rest. But if two perfectly *elastic* spheres meet each other as above, that at the moment of impact, the balls compress each other, which pressure continues until reaction has annihilated all the velocity of the globular bodies. At the same time the parts of the balls close to the point of impact have been compressed. If then, say they, there were no effort in the parts of the spheres to recover their former position, the balls would remain at *rest*. But they generally rebound, and if the recoil were complete, that is, if the parts of both bodies endeavoured to recover their position with an energy equal to that which disturbed them, the recoil would rapidly but effectually create in the balls a backward velocity equal to that with which they approached each other." From the latter part of the foregoing quotation, it is apparent that the cause of the recoil of one body from another after impaction, is attributed to the agency of the pressed in parts springing out again, which reaction has been designated *elasticity*.

(*a*.) Before accepting the above proposition, we would seek to be satisfied that the cause assigned, as accounting for the above phenomenon, is correct. It is found that the recoil of certain bodies after percussion varies very considerably according to their composition and texture. Thus small spheres made of hard stone—as boy's marbles—are perfectly inelastic as far as altering their form and dimensions by collision, as regards being indented by impaction, and their rebounding ability after percussion is found to be much greater than that of dry wood or ivory, or even india-rubber.

(*b*.) It has never been satisfactorily demonstrated, that portions of hard and brittle substances can assume their former dimensions after the indentation in question. On the contrary all evidence, by our senses, tells against this proposed contingency; we shall therefore presume that the above stated circumstance is assumed not proved. But allowing that these indentations of the balls under discussion, did ensue from the operation described, the energy of regression would scarcely shake off a

particle of dust, much more drive backwards the object after percussion. In fact the greater part of the ability employed in producing the said depression, must be expended in pressing out or exciting forth the latent heat or caloric of composition, and though the heat must return or be reabsorbed, as the supposed concavity fills up again, the surface in question is so circumscribed, that there could be very little vigour exercised. The case is different with elongated bodies in reference to elastic action, as in bending a spring, here we have too large surfaces engaged in the production of reaction, as explained in section 409 (*i.*)

(*c.*) If we make a depression in a solid caoutchouc ball, the effort of its springing back, though the substance is most resilient, is rather slow and feeble in its energy, and the effort is but slightly more effective when allowing a compressed bladder full of air to suddenly regain its former dimensions. Even a collapsed thick Indian rubber bottle, where there will be ample time to remove the pressure before reaction commences, and though the effort be assisted by the rushing in of air, yet in gaining its original form, the retro-action will scarcely lift or shake off a small piece of paper, although the regressive action produces a slight report, indicative of feeble electro-sonorous excitement. Further, if we employed a hollow metal or glass globe, the former might bend inwards but would not resume its prior position, and as regards the glass sphere, it would break before yielding, yet both these recoil after impact.

(*d.*) We may now I think proceed to put to the test the proposed sequence of indentation ensuing on the surface of hard and brittle bodies by percussion. If we take a solid ivory or glass ball, and place either in a vice, and then screw up the shafts of the instrument, it will be found (though we apply ten times the energy to the above spheres we could induce by impaction) that on applying the calipers, the dimensions of the spheres are not altered, and if we proceed with the pressure, it could be demonstrated that the balls would crumble before they yielded to an extent appreciable by measurement.

(*e.*) By way of proving the displacement of the sphere's surface by collision, the ball has sometimes been oiled, and then allowed to fall on certain hard substances, and the experimenter perceiving rather an extended spot of grease after contact, came to the conclusion, that the effect witnessed was the result of the sphere having been flattened against the

slab on which it impinged. But in this case, the oil on the ball resembled the moisture on a wet cloth, which latter being flirted impels the water to fly off, by checking the towel's course with the hand, but the fluid put in motion by this effort, received no hindrance to its transit, and of course, the water escaped from off the cloth. So it was with the falling oiled ball, its velocity was suddenly arrested, and by *electrical reaction* was driven up from the ground on which it impinged, but not so the oil that covered its surface, for it, the oil, being free to obey the motion imparted to it, during the transit of the sphere, it necessarily fled off, and was received by the slab from which the ball rebounded. There would have been nearly as large a mark made by the oil had the sphere been arrested or caught as it descended in a sufficiently deep ring, thus preventing it from coming in contact with the ground. The fluid would be here acted upon, like the head of the axe, situated on its handle, when the latter is struck upon the earth, in order to fix it more firmly. Besides, if the oil be applied very sparingly, the spot produced will be small in proportion, and if we increase the oleaginous fluid ever so little, the greater will be the mark produced, though falling from the same height. Now the larger or smaller mark occasioned by the increase or decrease in the quantity of oil, could not be the result of the flattening of the ball, since the amount of its depression must be the same, whether there was much or little oil applied.

Further, the spot would have been larger, had an aqueous or thinner fluid been made use of, because of the less tenacity to overcome when escaping from off the sphere. Again, if we use a thin moist coat of red or black varnish and now proceed as before to make the experiment over white marble, the mark will be a mere point as compared with that left when employing oil or water. Note also, that when we examine the newly stained billiard or pool balls, it will be found that the marks on their surfaces, after impact, are merely very diminutive spots, and these are produced by having their pigment knocked off.

(*f.*) Globular bodies do not rebound with that effort, when falling on wood or india-rubber, and especially upon the metals, as they do after impact with more brittle non-electric conducting substances, and yet the resilience of ligneous and caoutchouc materials, is much greater than that of slate or marble, and more susceptible of being indented, and here—as regards

the wood, metals, and india-rubber—we recognise the absence of that sharp sound, which is always indicative of electrical excitement, and is constantly produced, when brittle hard bodies impinge on each other.

(*g*.) Admitting that hard and brittle bodies can be depressed and that an elastic ability may in this way be excited into action by impact, the energy ought then to increase with the surface applied; yet the globular marble that touches the ground by a mere point, rebounds a thousand-fold more in comparison to what it would, if the same mass—fashioned from a like material—was made flat. The cause then of the phenomena of bodies recoiling or bounding upwards after collision must, we opine, depend upon electrical reaction, which economy will be hereafter discussed. When electricity is developed through certain processes, and particularly when brought into action by collision, its energies may be expended in many ways, as where it calls forth heat, sound, motion and combustion, &c., or it may be distributed by finding its equilibrium through means of conduction. For instance, when certain bodies come in contact, there is often produced a *sharp, ringing* noise, but not the expected motion, in answer to the effort made use of, as where we drive with great vigour one billiard ball against another. The sphere struck by the cue suddenly comes to a dead check after impact, instead of following the ball impinged upon. In this case the greater part of the energy is no doubt employed in producing or liberating a special or particular kind of acute sound, and probably at the same time a point of the arrested or reacting ball undergoes combustion. A parallel to this latter sequent may be noticed in muscular exertion or even during cogitation, neither of which processes can ensue (as shown in the excretions) without the cremation of a portion of fibrine, with the former, and brain matter, in the exercise of thinking, both of which are preceded by animal motion and electrical excitement. As regards electricity producing sound, this is evidenced when forming what has been called the electrical brush, which is developed, by allowing this fluid to escape from the extremities of certain wires. Thus, on holding a bluntish point, vitreously charged, towards uninsulated water, a star or quiet glow will appear upon it, and the surface of the water will be depressed by the current of air which passes from the obtuse extremity of the wire, but upon approaching the point in question nearer the water, *sonorous brushes* will succeed, and

the current of air will instantly cease, whilst the surface of the aqueous fluid will become level. Here a stream of electricity instead of producing motion calls forth or developes sound.

401. *Is the motion of Gravitation in falling bodies the result of electrical action and reaction?*

Newton particularly cautions his readers against supposing that there is really any attractive ability residing in the *centre* towards which bodies tend, this middle locality being only a *mathematical point*. He also takes care to mention that he uses the term to denote a fact and *not a cause;* and that he employed the proposition for the purpose of avoiding systems and explanations. This tendency, he suggests, might be caused by some *subtile matter proceeding from bodies*, and be the effect of a real impulsion, or that agency of one body acting on another; but whatever its cause might be, it was clearly a primary fact from which we might set out explaining other events or occurrences depending thereon.

(*a*.) Having by way of preamble, quoted the above paragraph, I will now—in all courtesy to those who have written concerning the foregoing enquiry as regards elasticity—proceed to give my own conception of the source from whence spring the phenomena dependent upon impaction or percussion.

A falling body is said to approach the ground, through the attractive energy of *gravitation*, and according to its mass and the squares of its distance, so will be the adductive ability thereof. This being true, when a ball is impinged on the great earth, it should become firmly attached to it, as a piece of soft iron is when brought in contact with a magnet; but we find on the contrary, that at the moment when the attraction of gravity ought to be at its maximum, it is instantly destroyed, and the sphere is seen to rebound from the locality on which it struck.

(*b*.) The flying up of the ball after its impact with the stony slab, has been attempted to be explained—as before quoted—by representing that the opposed part at the moment of contact, is forced inwards, and then by reaction, flirts out again, and this *supposed* operation was designated *elasticity*, and having employed this word for a conjectured process, all further research after ulterior *causes* would appear to have been abandoned. But with the reader's consent, I will resume the discussion of this subject, and in so doing, I hope to place the origin of the consequent in question before him in its true light.

(*c*.) If we suddenly project a sphere of ivory or marble on to

the pavement, the ball so thrown will be seen to rebound, not I conceive from the yielding of its surface, but from the electrical reactive blow received from the object on which it was cast. Now the ball in question weighs, say, one ounce, but from the impetus given, it struck the slab with a motor impress of 20 ounces, and of course, it received back a reactive blow from the body on which it was cast, equal to the latter weight, but as the projected sphere could only resist a quantity proportionate to its own gravity, the superabundant 19 ounces return stroke from the ground, must act upon the ball like a blow from a hammer equalling the weight in question; and of course the ball was impelled upwards. Further. Another cause producing the rebound of the sphere under discussion may be cited. Thus, it is known that bodies in motion have their *innate* and surface electricity excited into activity from the friction they are subjected to, whilst passing through the atmosphere, and the intensity of the electricity appertaining to the descending ball will be at the point nearest the earth, whose electrical condition will of course be in an opposite state to that of the falling sphere. Now, as the descending body touches the ground, there must ensue an *interchange* of the two electric fluids, that which is carried upon the ball will be discharged into the earth, whilst that from the latter must strike the most depending portion of the falling sphere, and of course propels it upwards, the intensity of the propulsion being always in accordance with the electric *conductibility* of the descending substance. Thus, ivory, stone, dry wood, caoutchouc, and especially shel-lac, are non-conductors of electricity, and therefore the return stroke against these bodies will be confined to the point touching the earth, but with metal balls—which are good conductors of electricity—they no sooner receive this fluid from the ground, than its effects instantly spread all over them, having no particular sway on one part more than another. It is owing to this electrical conductibility that metal balls do not rebound when cast on the pavement.

(*d.*) It might be here noticed that if we roll metallic balls along the ground, they will not—though of like weights—and projected with the same amount of energy—proceed so far or so fast, nor rebound to such a height, after being cast down, as those constituted of wood, ivory, or caoutchouc. This result—as regards the forward motion—is independent of compactability or the friction ensuing from their passage along or over the earth.

(*e*.) When the surface of certain spherical bodies is capable of being readily indented by impact—like lead and wet clay, &c., we find no resilient reaction in them, but on the contrary, they lie almost motionless after collision. Relative to the clay, it, like the piece of lead, becomes a good conductor of electricity whilst moist, but if we dry and bake it, now it is a very bad transmitter of this fluid, and will then after percussion, recoil equal to or even more than a ball made of ivory or wood.

(*f*.) That slight electrical excitement, will cause bad conducting bodies of electricity to fly up from certain surfaces, (may be witnessed in the well-known experiment of the pith-balls) where—by charging a bell-glass with this fluid, and placing these spheres underneath it upon the table, they will be seen to dance up and down, and to continue to do so, for a long period, until they have nearly carried off all the redundant electricity of the glass.

(*g*.) In the game of billiards, when the *hard* ball strikes the *soft* cushion (stuffed with wool or horse hair), it is said to be slightly indented, as is also the yielding ledge against which it impinged. Now if there is any knowledge ever reaped from mechanical experience, this effect, as regards the ball, must be incorrect, for had the obstruction that arrested the progress of the ivory sphere consisted of wood, the rebound would have been less, and had a metal been substituted for the ligneous substance, the recoil would have fallen much short of that produced by the wood, though these two latter objects must both have tended to indent the bony sphere more than the soft cushion. The fact is, the padding of the table ledge, was a bad conductor of electricity, and of course the reactive electrical ability did not spread or expend itself in calling forth or creating sound, (see *g*, sec. 410), and consequently the electric vigour from the cushion was all directed back on to the billiard ball, which being also a non-conductor of electricity, the energy of this fluid—combined with the reaction from the impact—was confined to a diminutive spot on the surface of the impinging sphere, and thus became the cause of its rebound.

(*h*.) If we suspend in a long row a set of ivory or shel-lac balls, (see *n*, "Action and Reaction"), the one touching the other, and then draw out the first of the series and let it fall back to its original place, it will not rebound on striking the chain of spheres, but the ball at the other extremity of the row becomes impelled outwards.

The same result ensues if we gently strike with a small

hammer the first hanging sphere of the series. This fact proves that no indentation takes place, followed by a flirting out of the substance of the ball, for if there had, the detached sphere would have rebounded on falling against the chain in question. Some persons have attempted to account for the rebound of the ball after percussion, in another way, namely, the sphere, say they, bulges out, at right angles to the line of impact, thus becoming ovoid in outline, and then suddenly regaining, by elasticity, its globular shape, flies up from the surface on which it impinged. But it has been found, that on dropping the ball to the ground, suspended in a linen tube, with just enough room for its descent, that no bulging of this hollow cylinder is seen to take place when the ball strikes the ground. Again, no amount of pressure even in a vice, enables us to elongate the diameter of the sphere under discussion. These facts denote that the ball in question does not alter its form, either by impact or pressure, so that neither of the processes proposed, namely, the indentation and subsequent flirting out of the surface, or extension of the diameter ensues after percussion. As the effects of collision then, are not explained by the theories advocated above, I am again urged to pronounce that the recoil of bodies, after impulsion, is the result of an electrical reaction.

(*i.*) If we dip spheres made of wood, clean ivory, caoutchouc or stone, into water, and thus render them better conductors of the excited electricity we shall greatly lessen their rebounding abilites, for the amount of recoil is found to be very far short of that effected when employing these balls in a dry state.

(*j.*) On casting an ivory or marble sphere upon a stone slab, it is seen to rebound to a certain height, but if the slab be broken into small pieces, and we now repeat the operation, it will be discovered that, though the descending body strikes, by its depending point, the centre of one of these loose fragments, it will recoil but little in comparison to what it did, when falling on the unbroken mass, by reason that the portion of stone struck cannot return an equivalent reaction, owing to its want of weight and inefficient connection with the earth. (See Article "Resistance.")

Further, if the original stone be rendered into powder instead of into fragments, then the sphere upon falling will not recoil at all, from the circumstance of its natural excited electricity being discharged into or among a number of granules,

that act and react on each other, and not conjointly upon the fallen globe. Yet the *weight* and the *amount* of motion may be the same, and the flattening and springing out again, as regards the ball, ought to have followed, and it should likewise have recoiled as a necessary consequence, whether the stone was whole or in small pieces, according to the theory on which is founded the exemplification of elasticity through collision. For we know that where certain solid bodies yield readily, as with lead, they flatten after impaction on very soft and yielding materials, as seen where the bullet strikes the water, which if still and deep, the projectile when in rapid motion, becomes levelled down as if it had struck a hard unyielding material.

(*k*.) The contractility of animal fibre, has been said to be unlike what is generally recognised as *elasticity*, because the latter can never act as a primary mover, nor is ever a source of ability, but merely the reaction of an energy previously applied. It is not affected by poisons or destroyed by death. "Contractibility"—it has been said—"can of itself originate motion." But contractility is always an *effect* and not a cause, how then can it become an originator as here proposed? The phenomenon of contractility must always be preceded by some electric or magnetic excitement, brought about through the agency of the nervous system in animals, and the life principle in the vegetable kingdom, for these being removed, we have of course no more natural contractility.

(*l*.) The elastic spiral fibres of the muscles of animals and the cork-screw like tissue of plants, &c., are acted upon by similar principles, for the nervous fluid is but another form of electricity or magnetism, of which there are many kinds, as we have various colours and numerous sounds, &c. Now the electricity and magnetism of the earth is as effective in its operation on the delicate requirements of the vegetable, as is the more energetic action of the nervous fluid to the animal.

(*m*.) As regards poisons, they destroy the prime mover or vital action of the animal elastic system itself, and consequently cut off all causation; they are found also to affect the natural economy of the living plant as effectually as that of the more highly endowed animal, only the effect is not so apparent, from the slowness of the action in the former, but then the vitality is less predominant in the vegetable, to what it is in living creatures.

(*n*.) Contractility like elasticity, must be preceded by certain primary operations. In fact every result we can witness is

the sequent of many efforts; all the effects that arrest our attention are anteceded by a number of linked causes, but our finite senses can only recognise the proximate occasioners of events or consequents.

(*o.*) It has been stated by authors, that "when an elastic ball is set in motion, and it strikes another at rest larger than itself, the latter is set in motion, in the same direction, whilst the former remains stationery." Now, had the sphere that struck the quiescent ball been elastic, as described by essayists, it would not have remained at rest, but must have rebounded after impaction.

(*p.*) *As regards electrical excitement.*—No friction, percussion, or even motion, can take place without producing electrical excitement—especially if these processes be exercised on dissimilar substances. By these operations the particles of bodies are brought rapidly into close contact with each other and as quickly separated, as witnessed where we rub glass on an amalgam (a combination of quicksilver with other metals) for the purpose of eliciting the development of electricity by means of the electrical machine. But there are many other modes, by which this all-effective agent may be evolved, in fact the energetic disturbance of the established equilibrium of the particles of bodies in any way, will be found efficient to call it forth in varying degrees of intensity. Thus, the forcible disruption of cohesion, mere pressure upon certain crystallized substances, the heating of others, changes of physical states, evaporation, and the process of crystallization, are all capable of producing electrical excitement. If we break a roll of sulphur, there will be found a charge of electricity upon its two surfaces, and if we pound a piece of this material in a dry mortar, and pour the fragments upon the glass of an electrometer, the leaves there present will diverge *very forcibly*, and if the contact be renewed with fresh surfaces upon a different plate, we shall find that it is not easy to deprive the fragments of the whole quantity of electricity they have acquired. Further, if we take a rhombohedron (a solid figure of six sides) of Iceland spar, and hold it by the two opposite edges, and then press upon its opposed faces, it will manifest a decided ability to attract light substances. Friction produced by liquids calls into effective activity electricity, as where a barometer, well freed from air, is first filled with mercury, and again, where a current of air is directed against a plate of glass, the latter will acquire positive electricity and therefore the air

PART VII.] **DECEMBER, 1879.** [PRICE SIXPENCE.

NEW VIEWS

OF

MATTER, LIFE, MOTION,

AND

RESISTANCE:

ALSO

AN ENQUIRY INTO THE MATERIALITY

OF

ELECTRICITY, HEAT, LIGHT, COLOURS, AND SOUND.

To be Published Monthly.

BY

JOSEPH HANDS, M.R.C.S., &c., &c.,

Author of "Will-Ability," "Beauty and the Laws Governing its Development," "Homœopathy contrasted with Allopathy," "A Dissertation on Diets and Digestion," &c., &c.

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AND ALL BOOKSELLERS.

PRELIMINARY REMARKS.

It is intended throughout the forthcoming work to point out certain novel characters in regard to the influencing attributes of Matter—by displaying through particular facts—the true agency that the atomized and unatomized or ultragaseous worlds, exercise in the economy of Nature. Added to which, will be an investigation into some of the more abstruse Laws governing the various kinds of Motivity. Also an inquiry touching the action of the Life-Principle as it manifests itself, whilst governing the development of the vegetable and animal kingdoms. Further, the Materiality of Electricity, Heat, Light, Colours, Odours, and Sound, are considered, demonstrating that these principles have most of the characteristics of corporalities—save that of ponderability or weight. In addition, will be a disquisition touching the qualitative causes of Resistance, and lastly will be annotations on Geology and Astronomy.

LITERARY NOTICES.

We have been favoured with a perusal of a portion of Mr. Hands' Work on "Matter, &c.," and can speak of it as a most able and interesting contribution to scientific literature.—*The Modern Physician*.—May, 1879.

Mr. Hand's Essays on Matter, Motion, Life and Resistance, &c., are replete with instruction and original conceptions of a very striking character.—*Human Nature*.—June 20th, 1879.

Mr. Hands, of Hammersmith, author of some very interesting works, has now adopted the plan originated by Dickens and Thackeray, whose books were brought out in monthly instalments. Mr. Hands's views are most original and illustrated by facts, his language stimulates the mental taste, like that of Robert Burton and Dr. Johnson, and pleases whilst instructing the reader.—*The Sussex Daily News*.—June 18th, 1879.

Mr. Hands has issued the second (July) part of his "New Views of Matter, Life, Motion, and Resistance." In many respects, this thoughtful and industrious author has trodden paths which are also explored by Dr Babbitt, in his great work on "Light."

These writers are pioneers in new fields of scientific research, and as such, a duty falls to their lot which cannot be attributed to a selfish motive. Mr. Hands is a true author, and gives to his readers profound original thought, at a popular price, his single object apparently being the education of the public mind in all its multitudinous forms.—*The Medium and Daybreak*, July 25, 1879.

must be negative. The rapid agitation of a piece of silk in the air, communicates to the latter positive electricity, whilst the silk becomes negative. Fibrine (a substance easily obtained from coagulated blood) when dry, on being rubbed in a mortar, becomes so strongly electro-positive, that the particles repel each other and adhere to the vessel in which it has been pounded.

ACTION AND REACTION.

402. *Action and reaction are always opposite and equal.*

(*a*.) *Action.*—In mechanics denotes generally the effort which a body or element exerts against another body or principle, sometimes it implies the effect or motion resulting from such effort. Mechanical action is performed either by percussion or by pressure. Relative to the former the effect is instantaneous, as regards the latter it is continued. In all cases of mechanical action the effect of the operating body is resisted in an equal degree by the *inertia* (inactivity) of the body acted upon, which resistance is termed reaction; and it is an axiom in mechanics, that action and reaction are always equal and exerted in opposite directions. Thus in driving a nail with a hammer, the stroke operates against the face of the instrument exactly with the same energy as against the head of the nail, and in pressing the hand upon a stone, the sway on the hand and on the stone is precisely the same.

(*b*.) *Reaction.*—A term used in mechanics to denote the reciprocality of an energy exerted by two bodies, which act mutually on each other; or the general fact collected from observation is, that any two bodies repelling or attracting each other, are made to recede or approach with equal momenta (the quantity of motions in moving bodies). Newton's third law of motion is, that "reaction is always contrary and equal to action, or that the mutual actions of two bodies are always equal and exerted in opposite directions."

(*c*.) It is the always emanating or undulating properties of bodies acting upon us, and our systems reacting back again on them, that make us conscious of their being. It is not by the touch that animals judge of things relative to their distance, motion, figure, or plurality. The swallow and bat catch insects on the wing. Birds when they leave their nest for the first time do not run against things, and they know an enemy a long way off. These facts show that living things must act and be reacted upon. Man acts on man, he cannot antedate his

experience, or guess what faculty or feelings a new object shall unlock; as with love, for instance, or revenge from outrage.

(*d.*) When a gun is fired, the ability of driving it backwards is equal to that of sending the ball forwards, taking into account the weight of the gun.

(*e.*) If a body in motion strike another at rest, the reaction of the substance at rest will rob the one in motion, exactly of so much motility as the required energy to put the body in motion.

(*f.*) All bodies fall at the same rate, whether large or small, and while the earth is acting on them, they also are reacting on the earth.

(*g.*) Bodies when stationary act and react on each other, in the dark, but when light is admitted to play upon them it increases this interchange of undulatory operation.

(*h.*) There is an action that follows certain inoculations—so to speak—where the reaction is not equal, but immensely amplified in its operative results; as after yeast has acted on the sweet wort. Again, as regards the influencing effect of fascination, made use of by one animal upon another, and also the agency of the soul or inner-man, employed in the process of Will-ability, so often displayed by electro-biologists. These responsive effects so produced, cannot be evenly contrasted with the operative sway thus oppositely exercised. The same may be asserted as regards the different kinds of impregnation. Further, the mind acts on the muscle indirectly, through the medium of the operation of the brain and nerves, whose weak, *soft*, fibres stir up the muscles to react so immediately, so mightily, that its fibres shorten and become *hard* without any preparatory oscillation, and they acquire all at *once* such an elasticity, that they become capable, according to Magendie, of vibrating or producing sounds.

(*i.*) *Collision* (from Collido, I strike against).—According to the theory of the schools, as before quoted, the first effect of the colliding of two elastic balls—as those made of ivory, is to produce a momentary union of the two spheres, and to compress and flatten the impinging surfaces. The next is the effort of the bodies in question to recover their figure or shape, and when the elasticity is perfect (as is here supposed to be) the compressed surfaces are restored by reaction, with an energy exactly equal to that by which they were displaced. This restoring ability, produced by the elasticity, is called the

recoil, and its operation is to double precisely the effect that would be produced if the bodies were non-elastic. In answer to this statement, I would remark that I have often seen two billiard balls in motion meet each other, and both come to a dead standstill; now if the above theory was correct, this sequence could not have ensued. It has often been noticed, that when two balls are stopped in this way, there always ensues—as before noticed—a particular shrill sound, showing that the motion was arrested through electric action, and the sharp detonation heard denoted that the two moving energies were expended in developing or calling forth sound. In fact during the percussion of any two bodies, more or less of the vigour of motion is expended in producing or waking up sound.

(*j.*) *The creation of motion by attraction is accompanied by the development of an adverse motivity.*—If a magnetic and non-magnetic needle be placed in water, not only will the magnetic instrument move towards the other, but the opposite needle will tend towards the magnetic one. It appears then that opposite motions are to be considered as contrary effects: and if applied to the same body, we know that they will destroy one another. If the magnetic and non-magnetic needles be of equal mass, they will at the end of any time have equal and contrary velocities, but if the magnetic needle be double the size of the other, it will in the same time acquire only half the velocity. In fact action and reaction will be found equal and contrary. We have not learnt the meaning of the word action, so long as we think only of velocity, and not of quantity of matter in which velocity is created. A cause of motion once existing, and which was entirely expended in giving a velocity of 100 feet per second to a ball of two pounds weight would have given 200 feet per second to a sphere of one pound weight. Hence it is momentum, which is the measure of the action of matter upon matter, and the definite enunciation of the third law is as follows:—" Whenever any matter gains momentum in one direction, other matter either loses so much momentum in that direction, or gives as much in the contrary direction." Action then is creation or destruction of momentum; the destruction of momentum in one direction, and its reaction in the contrary direction are equivalent effects. It is said that on walking forwards upon the earth, which friction enables us to do, our feet obviously act upon it; and whatever momentum is communicated to ourselves, the same is lost to the earth, or gained in the opposite direction, and the same

may be said of a person who jumps upwards.—Penny Cyclopædia, v. 15, p. 453.

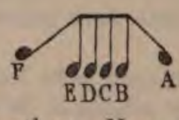
(*k.*) If we fasten a string to a post, and pull with an energy of 100 pounds, it may not at first appear that the post also pulls the string, because we may not be able to conceive the latter acting, but only resisting. Nevertheless, the part which the post sustains, call it action or resistance, is still the equivalent of an energy, for if it were removed, and another person's hand applied to the other end of the string, that hand must also pull against the first operator with an ability of a hundred weight before the counteraction of the moving tendency of the first pressure is supplied.

(*l.*) *Further illustrations of action and reaction.*—If a moving body strike an impediment, the energy of the impact, and the resistance of the impediment, are equal. Thus, if a ball is thrown against the side of a house with an acting energy of three, the house resists it with an equal ability, and the ball rebounds. If it be thrown against a pane of glass with the same energy, the glass having only the ability of two to resist, the ball will go through the window, still retaining one-third of its received energy.

(*m.*) *Energetic action and the resistance to it are equal.*—Thus, when a moving body strikes one that is at rest, the stationary body returns the blow with equal ability. This is illustrated by the fact that if two persons strike their heads together, one being in motion and the other at rest, they are both equally hurt.

(*n.*) Action and reaction may be further illustrated by a number of ivory balls suspended by threads so as to touch each other.

If the ball A (see diagram) be drawn from the perpendicular, and then left to fall so as to strike the one next to it, the motion of the falling sphere will be communicated



through the whole series from one to the other. None of the balls, except F, will, however, appear to move. This may be understood when we consider that the reaction of B is just equal to the action of A, and that each of the other balls, in like manner, acts and reacts on the other, until the motion of A arrives at F, which having no impediment, or nothing to act upon, is itself put in motion. It is, therefore, reaction which causes all the balls except F to remain at rest.

(o.) The above result is produced from an electrical action, for if the ball A became indented, as proposed by authors as the explanation of the property of *elasticity*, the sphere A ought to have rebounded; but being an electric operation, the fluid, or its effects, was transmitted through the chain of balls by means of the innate magnetism, or electricity of composition resident in each, and displayed its energy on the sphere F, which, of course, was propelled outwards.

(p.) It is by a process of action and reaction that rockets are impelled through the atmosphere. The stream of expanded air, or the fire which is emitted from the lower end of the rocket, not only pushes against the rocket itself, but against the atmosphere, which reacting against the air so expanded, sends the rocket along.—Dr. Comstock.

We must here also take into account the thermo-electric energy that propels the rocket forward.

(q.) *Polarity, or action and reaction.*—We meet with this in every part of Nature.

"Thus, we have darkness and light, heat and cold, the ebb and flow of water, male and female, inspiration and expiration, in the contraction and dilitation of the heart, in the undulations of fluids, and of sound, in the centrifugal and centripetal gravity, in electricity, galvanism, and chemical affinity. Superinduce magnetism at one end of a needle, the opposite magnetism takes place at the other end. If the south attracts, the north repels. To empty here, you must condense there. An inevitable dualism besets Nature, so that each thing is a half, and suggests another to make it whole."—Emerson, p. 75.

RESISTANCE.

403. Before entering upon this disquisition touching Resistance, I would ask, what this quality appertaining to the material world is?

Under what circumstances does this property vary, and and what are the agents through which its being is developed? Whilst annotating on this capacity of matter, I shall endeavour to answer the above introductory questions.

(*a*.) Resistance has generally been interpreted "as a *force* acting in opposition to another force, so as to destroy or diminish its effects."

(*b*.) This definition does not assist us the least in understanding, or rather feeling, what the *property*, termed force, is; for this word, like its associate *power*, images to the senses nothing, and as at present employed, serves but as a mere term to hide our comprehension of the character of this endowment of matter; since we find the explanation of these words (with many others) summed up finally, as the *that* which produces many natural phenomena, and especially opposes, or changes, motion.

Now, as the foregoing appellations fail to interpret in the slightest degree any of the attributes of Nature, I shall resort to a few simple processes, whereby to assist in construing to the reader some of my impressions regarding these abilities commonly termed *force* or *power*.

(*c*.) The resistance which certain bodies offer from their inertia (inactivity) to the efforts made use of, to remove them when at what has been designated *rest*, from particular localities, will be found to vary considerably: 1st. Where they differ in *composition*, as whether organic or inorganic, metallic or otherwise. 2nd. Opposition to horizontal displacement is modified, by *form*, as regards their being round, angular, spherical, or flat. 3rd. Situation makes a difference in the facility of transference from one place to another; as when moved over smooth or rough surfaces, or across localities that

deviate in attractive qualities, or retard by offering frictional impediments.

4th. Time alters the amount of antagonism to displacement, as where substances have been lying in some locality for a lengthened period, or only recently deposited. The former circumstance, as regards time, is especially recognised in the arrangement of the molecules of substances during aggregation. Relative to suspended bodies, their resistance to motion is diversified very materially by the mode or direction in which the stress is applied.

(*d.*) If a cube weighing 100 pounds be placed on a smooth surface, it will be found that we must exert an energy equal to that quantity in lifting it from the ground, or pushing it directly upwards when suspended, but an effort applied adequate to 60 pounds is the equivalent to remove the same body from its situation (when recently deposited) if the pressure or pulling be exercised so as to bear in the horizontal range. If we employ a globe of the same weight, instead of a cube, it will require a like measure of energy to elevate it; but an applied ability, considerably under 60 pounds, will cause the point on which the sphere rests, to slide over the smooth surface that may give it support. Further, it is found that a magnet will draw a much larger piece of soft iron over a given surface than it can lift upwards from the ground.

(*e.*) On suspending a body of a like weight to the above, it is noticed that an effort, only equalling a pressure of a few ounces, if applied laterally, will suffice to push with the finger, or pull by means of an attached string, the object in question, from its perpendicular position. This latter result is also produced, in a measure, from percussion, as witnessed on letting a small substance fall against the hanging body. This motory result, after impaction, does not ensue immediately, as all inanimate bodies acted upon by collision rest a time before the commencement of the rebound.

(*f.*) *Action and reaction are always equal and exerted in opposite directions.*—I shall familiarise this axiom by a few simple experiments. Most persons, whilst pulling towards, or pushing from them, a firmly-fixed post, would suppose that the stationary object remained passive, and that they alone were acting, but practice and reflection teach us that such is not the case. The post in question, and its attachments, upon which the essay is being made, will be found to offer an equal amount of antagonism to that of the experimenter's efforts.

The first hindrance resisting the exertion of the operator will be the weight of the post, the second source of the counteraction takes place from the ground, &c., into which the piece of wood is inserted. Perhaps a living test will assist more readily in displaying our proposition. Thus, if the person seeking for information asks some one to present his hand, with which to adopt the same procedure as applied to the post, he will directly be made aware that his companion must employ an exertion of pulling or pushing equal to that formerly made use of in relation to the post, but in an opposite direction; and if his companion does, or cannot, call forth an equal antagonistic effort to his own, then his comrade's body must either advance or recede, according to the direction of the applied stress, in order to equalise the struggle between them. Thus we perceive that all that portion of the strength put forth, which was not resisted, becomes expended in creating motion in the opponent's person.

(*g.*) It is not always recognised by the unreflective that if we strike a substance with the closed hand, it will return the blow to an amount exactly equal to the sum of the application; hence the pain, or injury, if the feat be exercised with a certain energy, we suffer from the effects of the reaction, or backward stroke. This reactive result is likewise illustrated where an individual strikes his head against another person's, the one being in motion, the other at rest, both are equally hurt. The effect, of course, becomes doubled if both their heads are in equal motion at the same time in opposite directions.

(*h.*) *Further illustrations of the quality of resistance.*—If we place two balls on a level plane, at a given distance from each other, the one weighing 10 and the other 100 pounds, and strike with a mallet, or rod, the smaller of the two spheres, with an effort equal to 20 pounds, it might be supposed because the minor globe at the moment of receiving the impact from the mallet or rod, condenses by reaction a certain portion of the applied energy, that upon its contact with the larger body, the impress of the concussion would only be equal to 20 pounds; but this is not the case, for the back stroke of the smaller ball towards the mallet is generally expended in generating or calling into action heat, electricity and sound; besides, the mallet returns again any portion of the energy given back, which is not employed in forming or liberating heat, &c., and before another reactive effort can take place, from the lesser sphere, in the direction of the mallet, the

smaller body will have moved onwards, striking the larger globe, with nearly the impulsive vigour of the 20 pound blow it originally received, to which 20 pounds must be added its own weight, or rather that quantity it was capable of resisting before being set in motion by the given impetus. The rebound which takes place after the impact of the minor with the major ball, proceeds from the former having received back by reaction from the latter, an energy equal to 20 pounds more than its own gravity could overcome.

(*i.*) I would here ask, whence spring the causes of this action and reaction of the spheres in question, the one upon the other, and how are the effects which we witness developed? Now it may be presumed that the re-percussion, or reflected energy received by the minor sphere, after the collision of the globes, is equal to 30 pounds; but 10 of this 30 pounds refluent ability can only belong to the reaction necessary for the overcoming of the minor ball's weight. It follows then, that the remaining 20 pounds stress appertaining to the back stroke, must emanate from something not immediately evident, and I suggest that the superabundant ability brought into operation, was the result of, first, the electro-magnetic energy exercised by the person dealing the blow. and secondly the action and reaction of the thus aroused innate electricity of composition, appertaining to the ball struck by the mallet, both of which effects were delivered during impact to the greater sphere, waking up in the latter its own inborn electricity, the action and reaction of which became reflected back into or upon the lesser ball causing its rebound. (See article "Motion.")

In the foregoing experiment, it may be discerned, that if the smaller strikes the larger sphere opposite to its centre, the latter will in appearance be affected but little beyond slight oscillation, but if a Melloni's battery be applied to the surfaces where contact ensued, it would demonstrate that a certain degree of heat was evolved, showing that a portion of the resistance exerted in overcoming the weight and motion, was expended in rousing into operation the innate heat and static electricity belonging to the opposed bodies, and the other measure of resistance, not so exercised, caused the balls to act and react on each other.

(*j.*) We will now arrange the spheres as before, and again strike the 10 pound ball with an energy equal to 95 pounds, causing it a second time to come in contact with the hundred

pound globe; and now we observe (though employing the same amount of matter as on the previous occasion) a difference in the sequence. The heavier ball after concussion, instead of oscillating, will now move forwards in the direction of the applied impetus, by reason that the large sphere cannot condense, by reaction, the amount of vigour applied by the impulsion and weight of the minor ball, which latter, after delivering to the greater sphere an energy equal to the overcoming of its *inertia*, thereby setting it in motion, is seen to follow in the same track, and so they will proceed until both expend their momenta, which is effected by delivering one part to the earth, and transmuting—so to speak—another portion of their motivity, by means of friction, &c., into heat and electrical excitement.

404. It has been generally stated by authors concerning certain pendent bodies, "that if we suspend from a rod a set of balls by threads (see diagram) in such manner that they shall touch each other, and then draw out the ball A as far as A' it will be found on letting it fall against B, that after a moment's pause, the sphere E at the other end of the hanging series, will be driven out to E', or a distance equal to the removal of A to A', and that on the return swing of E' back again to E, this impact will send A again out to A'. In this manner the balls A and E will—pendulum-like—vibrate without B, C, D, being in any way displaced, and this effect will ensue through any number of pendent spheres."

(*a*.) On testing by experiment, it will be found that there are certain errors in this statement, but it is a habit among writers, when compiling books, dedicated to science, to copy the manuals before them, without trying for themselves the facts therein reported, and hence arise the many mistakes found in publications treating on natural philosophy.

(*b*.) It will be experienced by persons seeking the proof of the foregoing statements, that if they employ only three balls instead of a greater number, that the sphere A' after the return descent of E' will not describe so large a portion of an arc, as the ball A' first drawn out for the purpose of showing the experiment, in fact as we increase the number of spheres, the flying out of A after repercussion is lessened.

(*c*.) It is asserted, that the central balls B, C, D, of the diagram, are not displaced by the percussion of A' and E'; but

it will be found whilst experimenting, that the whole of the spheres are moved, and this even if the ball employed to make the essay with be only 1-20th the weight of one of the spheres making up the chain. This result follows through a very long row of balls, whose combined weight may exceed a thousand-fold that of the smaller sphere employed to demonstrate the issue.

405. *Effects vary according to change of circumstances.* Thus altering results ensue, in relation to the *shape* of the bodies employed to demonstrate certain issues. Further, the *composition* of the substances made use of, vary the sequents after impaction, as do their *investments*.

(a.) On employing square, instead of spherical bodies, for our operations, it will be found that the cube E will not, by the falling of A' against the series, be thrown out from its position, but the whole chain is seen to oscillate from side to side, which effect is much lessened, if the cubes—when made of wood—are arranged across their grain.

(b.) If we hang at each end of three suspended solid wooden squares, of like diameter, a ball equalling in weight one of these cubes, and then proceed as before, the results will alter as compared with the experiment *(a)*.

The same oscillation from right to left of the cubes, succeeds this change of appliance; but the sphere E now only departs very slightly from the square against which it hung, and the ball A that was drawn from the perpendicular to make the essay with, remains nearly in the situation, where its motion was arrested by impact with the pendent cube B.

(c.) If the ball E—of the above arrangement of spheres and cubes—be covered with a bad conductor of electricity, as india-rubber or thick woollen cloth; on causing one of the squares at the opposite extremity of the chain to fall against its fellow, the encased ball E will be driven out *further* than when in an unclothed state; but if a naked sphere be substituted for the cube employed to make the first impact with, the flying out of the covered ball E, is increased. Again, if the two spheres at either end of the chain be encased, then the ball E will be still further driven out, but the sphere A in place if remaining stationary, rebounds slightly after impact with the series of squares.

By the employment of cubes, the excited innate electricity (supposing this fluid to be the agent of the phenomena) brought into action by the motion and collision, may be discharged

from their pointed angles, besides the effect of the percussion is diffused over a large surface, instead of being concentrated on the point opposite the centre of gravity, and thus the intensity of the excited electricity becomes enfeebled, by reason that a thousand parts comparatively speaking, of the square's superficies, receives and gives back the energy from the impact, whereas with the sphere, the whole resistance is brought to bear upon a very circumscribed spot.

(*d.*) If the chain of wooden or ivory balls be suspended by white silk threads, and A alone be covered with thick cloth, or india-rubber, on letting it fall after removal against the string of spheres, now the ball E will not be driven out, but is seen to oscillate with the rest of the chain, whilst A is observed to rebound after impact. If however we cover E and A with thick cloth, then E flies out and A rebounds after its collision against B.

(*e.*) When the whole chain is covered with india-rubber or thick cloth, and we proceed as before, now E is ejected from the line of spheres and A rebounds after its fall against B. In fact all the balls separate from each other, only those in the centre to a much slighter degree as compared with the spheres at each end of the chain. If for the covered ball A we substitute a ball of shel-lac, now E is more effectually ejected from the series of spheres.

(*f.*) If we employ five balls, allowing B, C, D, to be made of ivory and A and E of shel-lac, then E after the impact of A against the chain, will be driven out to a greater extent than where all the spheres are composed of bone. Now the shel-lac sphere A unlike the one made of ivory, instead of resting after its fall against B, rebounds, and the intermediate balls between A and E also behave differently to what they do, when struck by ivory, for they then oscillate as well as separate from each other, only their separation is in a much minor degree as compared to the two terminal shel-lac spheres. This effect is especially enhanced if we excite by friction, with silk or woollen fabrics the two extreme shel-lac balls. By diminishing up to a certain degree, the distance of the drawing out of A from the perpendicular to let it fall through its diminutive arc, so will the increase of the rapidity of the actions and reactions be enhanced between each sphere. Now it is found that if we moisten the balls before proceeding to experiment—thus rendering them better conductors of electricity—then the flying out and rebounding of the spheres is much

lessened, and if the balls be made very wet, the action and reaction are almost nil.

(*g*.) In the foregoing experiments, a great difference in the mode of action and reaction ensues among the spheres, accordingly as they are struck in the centre, as regards the even line of their suspension or otherwise. *Composition* alters the operation of the one on the other, as does the condition of being at relative *rest* or in motion. An increase in the number of balls or solid cubes, likewise modifies the effects produced, as will the intermixing of them when of various sizes. In fact the results vary with each change adopted. Again, the action of bodies becomes diversified, accordingly as they are suspended by conductors of electricity, as by means of metal threads, or non-conductors, as when hung by white silk cords. Had metallic—especially leaden spheres, been employed in the place of ivory or wooden balls in the above experiments, none of the foregoing phenomena could have ensued, by reason of their being good conductors of electricity, and the sphere E would have remained stationary, the chain merely oscillating from side to side.

(*h*.) It was demonstrated in the essay on "Elasticity" that it is not from indentations and springing out again of the substance, or the passing from the spherical into the ovoid form, that the ball E flies out after the impaction of A' against the chain of spherules, because the thick cloth or india-rubber sheathing would effectually prevent this sequent, as well as the sonorous vibrations of the balls. Besides when ivory comes in contact with ivory, as is the case with uncovered spheres, the falling globose body A' lies quiet, after impact against the chain of spherules. Now if the surface of the ball A' had been depressed and then flirted out again, constituting the so-called elastic ability, this sphere after its descent ought to have rebounded from the ball A against which it impinged, and not t have observed a passive state. Further, the greater the energy of impact—which ought to increase this said elasticity—the more steady the sphere A lies against the chain of balls, and especially is this a sequent, when a sharp sound is produced by the percussion. In this case the action is like that of the two billiard-balls, which has been such a celebrated difficulty for authors to explain on the supposed laws of elasticity—where if the collision is of a gentle character, the ball after impact, moves onwards, following the one it came in contact with; but if the sphere struck by the cue be driven with great

energy—so as to produce a *jarring report* after impinging on its opponent, it will remain at rest, or spin on its axis. The shrill sound evolved, would point out, that a portion of static or innate electricity, was thrown into vivid excitement, and discharged into the air, thus waking up or being transmuted into sound, like that produced by a whip where motion terminates in producing an electric smacking noise. All sounds must be preceded by some kind of motivity, and each body in motion must give rise to electrical phenomena.

(*i.*) The causes of the different results witnessed during the foregoing experiments, will be more readily conceived I think by attributing them to the agency of electricity, combined with the conducting capability of this fluid by the bodies employed to exhibit the phenomena; for it would appear that as the capacity among substances, of conveying electricity lessens, so will their rebounding energies be increased.

(*j.*) If an excited *electric*—that is a non-conductor of electricity—as a ball made of shel-lac, be struck or rubbed with a piece of silk or flannel, so as to rouse into action its innate electricity or that appertaining to its composition, you can, on touching it, only discharge just the point where contact took place, but if we employ a non-electric, or a good conductor of electricity—such as a metallic sphere, and charge this (when suspended by a piece of white silk thread or placing it on a glass stand) with electricity, either directly from an electrical machine or by friction of its surface, through means of a clean silk handkerchief, then on touching this *non-electric* with a conductor, you can discharge the whole of its surface electricity. But if this electrically charged ball be touched by an *electric*, such as a sphere of sealing wax or a ball covered with thick woollen cloth or caoutchouc, you then can only take away a small circumscribed portion of the surface electricity from the charged metallic globe, by reason that the electricity in question cannot spread over the *electric* or shel-lac sphere. Thus we can only charge a mere point, or just the spot of the wax or cloth-covered ball that was placed in contact with the charged metallic sphere. (See article "Elasticity.")

(406.) Robins' Balistic (relating to projectile engines) Pendulum must have been a fertile source of error, as regards the exact measurement of the energy or velocity with which discharged balls, &c., would strike it, especially if they had been constructed of different materials.

iron plate now becomes the injured body, and the bullet, instead of being shattered,—though consisting of soft metal—passes easily through the depending target, and the ball if examined will scarcely be altered in form, like the tallow candle, which if discharged from a gun, is seen to readily permeate the *open* door, or a piece of suspended board.

As regards the projected bullet, this, though only weighing 2 ounces is enabled after its propulsion from the rifle, to strike the target in question, with an energy—as before suggested—equal to a pressure say of 300 pounds, but it, the target, not being able (especially the spot where the stress was applied) to resist more than its own weight, 25 pounds, of course its surface gave way, whilst the pendent-butt, as a whole, scarcely vibrates from the shock. The perforation thus made in the target will be found as clean round its edges, as if cut out with a stamp, as is the case when a bullet passes through a window-pane. This piercing of the iron plate partly depends upon the principle, that when a large body is violently struck by a smaller substance, a period must elapse before the effect from the percussion can be communicated throughout the particles of the greater mass, and thus before the resisting efforts can spread—even to the portions situated around the point receiving the blow, the ball will have made an aperture through the hung target.

(*c*.) *Further relative to resistive action and reaction.*

The astonishing effect produced by the discharged bullet upon the pendent iron target, may be further illustrated by observing how much more readily and effectually we can drive a nail or wedge into a suspended cylinder of wood, than into the same, when lying on the ground. The dimensions of the suspended piece of timber (the larger it is the more effective the result) should be comprised in its length, so as to have the resistance exerted chiefly in a direct line. The sequent of the appliance will also be enhanced, if we employ a hammer-head, whose size may lie in its longitude rather than in its width. It has not been generally recognised by our artificers, in constructing this most effective of all manual tools, that its principal operative capabilities lie in the length of the head and handle, rather than in its magnitude; so that its chief mass shall be brought to act in a direct line with the nail or wedge, which nail and wedge should be struck with the centre of the hammer-head. By attending to these circumstances, we should scarcely if ever turn the nail (its head being properly shaped)

as is so frequently done especially by persons unacquainted with the use of this instrument. In driving a nail into a stick of timber, we find the former is acted upon at both its extremities. First through its head from the *action* of the hammer, secondly at its point by the *reaction* or back stroke bestowed by the piece of wood. Here the motion of the hammer—combined with the animal electro-magnetism of the driver—gives rise to a stream of positive electricity, which rushes through the nail into the piece of timber, and the latter returns an equal quantity of negative or opposite electricity, which is received by the hammer and delivered to the person using it.

Thus action and reaction may be here compared with the operation of the two opposite states of the electric fluid, and as we can never demonstrate the one without developing the action of the other—both always taking equal and antagonistic bearings—there must be of course an interchange of the fluids, both passing in opposite directions.

(*d.*) The source of all the foregoing phenomena as regards firearm-projectiles, would appear to be from electrical agency. Thus, we may readily suppose that the flying bullet has had —through the operation of the powder—its innate electricity of composition aroused into intense activity, which combined with the motion of the projectile, and its disengagement from the earth's attraction (see article "Motion,") enables it to pierce the hanging target, as the spark from the Leyden-phial does the book or plate of glass. But with regard to the sheet of iron under discussion, whilst it is lying against its support—though it is the same circumscribed spot that is struck—the positive electricity carried in and upon the bullet, is of course conducted by means of the target into the wall or bank against which it rests, whilst the equally intense negative electric fluid, emanating from the earth—coupled with its reactive control—operates on the leaden ball, and thus splits it into pieces, and as regards the motivity of the bullet, that would appear to be spent in developing heat, light, and sound, &c.

(*e.*) *Relative to individuals that have been killed by the passage too near them of the cannon ball.*—This result has generally been attributed to the rapid propulsion of the roaring air that surrounds the projectile during its flight. But, it should be remembered, that the atmosphere the shot is passing through, is pierced by the rotating ball, like the gimlet boring a piece of wood. And again, it is the air in front of the projectile that is chiefly acted upon, and not the adjacent element

surrounding it. This accident would appear to ensue either from the electrical excitement set up in the atmosphere through which the ball is pursuing its course, or from the electricity carried in and upon the projectile, which acting like a flash of lightning kills the individual.

(*f.*) It may be asked, after what manner the ball weighing only 2 ounces is enabled to strike the target with an impulse equivalent to 300 pounds. Some persons may exclaim that the effect is produced by the explosive energy, meaning the sudden expansion ensuing from the powder passing into a gaseous state; which considered in a mechanical sense, may in a measure appear feasible, because it can be likened perhaps to the reacting impetus that the bow-string gives the bolt, when discharged from its fastening. But there is another unrecognised reason I conceive, which is the chief cause of the phenomena under discussion. It should be remembered, that it is not a solid which acts on the ball, but a gas, light as air, produced from the burning of a little gunpowder, that if set fire to in the open atmosphere, would only have yielded—as regards sound—a mere puff, and the energy created could scarcely by its action have elevated a piece of paper from the ground.

(*g.*) If the resulting sequence in question had been chiefly accomplished by the ignition of the ingredients employed, the larger the quantity made use of, the greater would have been the ability displayed. But, we find in tactics, that the more powder there is employed, beyond a given measure, the less is the explosive energy obtained by its action, and not only is the flight of the projectile diminished, but its effects on the opposing object (though near the gun, as in sea engagements) is lessened. Besides, the ball's course is more apt to deviate from a right line. These facts are well known now, though they were not by our forefathers, who expended a vast amount of powder (thinking the more they used the greater would be the sequence) to no purpose, except that of failing greatly in the object they had in view. It may be here mentioned, that in olden times, during sea-fights, a large portion of the powder placed in the cannon fell into the sea unexploded.

(*h.*) Might not the phenomena relating to the subject before us, be more approximately attributed to a series of actions and reactions taking place between the burning particles of the powder, the ball and the fire-arm? (See article "Motion.") For instance, when gunpowder is employed as an explosive

agent, the granules are known to be ignited in succession, or one after the other, so that a certain *time* would appear to be necessary, in order to allow the creation of a definite energy. This economy is often demonstrated, where the gun "hangs fire"—as it is expressed, for in these cases, the ball or charge is found to leave the destructive instrument with greater energy and to travel further and truer from this occurrence having taken place.

Another fact teaching us that a given period is desirable in order to be more exact and operative, was shown, where the French employed detonating ingredients to effect their purpose, which gave rise to the saying, that "the ball went any and everywhere" and was found always to fall short of the distance accomplished, when employing gunpowder. Gun-cotton and nitro-glycerine are not by any means so steady and true in their operations as the old powder granules.

(*i.*) The polishing by attrition of the grains of gunpowder gives it a distinct quality, whereby heat and especially the electrical results, are more *quickly* excited into action during combustion. Besides, so treated, it is always found to be much more readily effective—as regards fire-arms—in its operation, and it is likewise noticed that a smaller proportion will suffice from this usage of the granules.

(*j.*) Gunpowder when employed for artillery purposes, must be in a loose state, in order to allow of the presence of sufficient air, for the purpose of the formation of combustive heat, which caloric—when confined—gives rise to those transmutations, so necessary to electrical excitements, and these latter would appear to *generate the energy*, that is to drive out the projectile, and gives it mostly the destructive ability displayed, when meeting with opposing objects. Unless this circumstance, of allowing sufficient air to be present, is attended to—as regards gunpowder—we shall fall short of the desired object, as experienced when the grains of powder are rammed down too tightly, for in this case, the flight of the ball becomes less vehement and does not pursue so steady a course. It is known, that when guns are loaded at the breech, if a small chamber be made behind the cartridge next the powder, so as to supply it with sufficient room for the air to act on the granules, the energetic effect is surprisingly enhanced. This must be attended to when blasting rocks with gunpowder, which should be loosely deposited in the cavity made for its reception. It may be here noticed, that fine glazed powder is

not so effective in loosening blocks of stone from the rock during its combustion, by reason of its action being too quick, thus not allowing time for the innate electricity or pyrogen of composition, appertaining to the surrounding masses, to be brought by reaction, into a sufficient state of excitement; therefore the quarry men employ coarse gunpowder for this operation, besides there is more room for air or free oxygen among the granules.

Further, from the circumstance of the rock-powder being coarse in the grain and rough and unpolished on its surface, it becomes a worse conductor of heat and electricity. This is another cause retarding the action of this kind of gunpowder.

(*k.*) *As regards gun-cotton and nitro-glycerine.*—These substances have more pyrogen or the electricity of composition situated among their constituents than any other conbustibles we are acquainted with, hence their extraordinary rapid and effective operation and destructive capability of acting, almost without the presence of air. The imponderable principle of pyrogen, though diffused more or less throughout all bodies, cannot at present be demonstrated as a *separate* element, by any chemical abilities known to us.

(*l.*) *Tremendous effects of the explosive action of gun-cotton and nitro-glycerine.*

A mass of gunpowder confined with a certain portion of gun-cotton is said to exert an explosive energy four times greater than that developed by the ignition of the gunpowder in the ordinary manner. A palisade, constructed by sinking 4 feet into the ground trunks of trees 18 inches in diameter, was completely destroyed at Stowmarket, by the explosion of 15 pounds of gun-cotton. Huge logs were sent bounding across the field to great distances, and some of the trees were literally reduced to match-wood. This explosive material was simply laid on the ground. The destructive ability of nitro-glycerine is even greater than that of gun-cotton. A tin canister containing only a few ounces of nitro-glycerine, was placed, without being confined, on the top of a smooth boulder-stone of several tons weight. This material was then exploded by a fusee containing fulminating powder, which was fired by electricity. The stone was thereby reduced into a thousand fragments. This experiment shows the advantage of nitro-glycerine over gunpowder as a blasting material, being ten times greater than that of powder and six times that of gun-cotton. A charge of gunpowder inserted into a vertical hole tends to force out a

conical mass, the apex being downwards. With nitro-glycerine and gun-cotton, an able rending action is exerted *below* as well as above the charge. These latter materials need not be like gunpowder confined, but only dropped into the drill-hole.

(*m.*) The *striking down ability* of gun-cotton and nitro-glycerine, shows that this result ensues from electrical action and reaction. The pyrogen, which forms one of the chief constituents of these materials, becomes liberated, and during the action of its explosive energies, it rouses into operation the static electricity of composition, present in the bodies that the explosives are acting upon, and by catalytic (action by presence) reaction, frees itself from its combination with ponderable matter, and is thus enabled to exercise its dynamic abilities, and thus came about the destructive results witnessed.

(*n.*) *Touching the fact that gun-propelled balls carry an enormous amount of electricity in and upon them*, it was observed, as regards projectiles discharged by means of condensed electric steam, that there was always a flash of light given forth, after the impact of each bullet against the target that arrested their course. This flash is produced from the liberation of the electric fluids which accompanies the projectile.

It is the electricity resident in condensed steam that draws or works the engines employed for mechanical operations. (See article "Motion.")

(*o.*) When trying the effects of Sir J. Whitworth's projectiles on the sides of the floating iron clad batteries, there was constantly observed an extensive bright blaze of light emitted at the instant of impact of each ball or bolt against the iron plates. I may here point out, that had these *floating* batteries—and especially their plates—been deposited (like the iron target in the experiment *b*) against a large rock, the ball or bolt instead of piercing them, would have rebounded or been split in pieces; from the fact of the rock as well as the plates resisting by reaction the motive ability of the projectile.

(*p.*) In summing up I may state, that pyrogen or electricity, with magnetism, heat, &c., control all natural and mechanical operations, however insignificant or mighty, circumscribed or vastly extended they may be.

I must therefore presume that it is acting and reacting electricity, which is operating in and around the projectile before it leaves the gun, atteuds its course through the atmosphere, and presides over its terminal effects.

It should not be forgotten, that the same intense energy, produced, by the combustion of the gunpowder, acts on the ball as well as the gun. It is the resistance to this energy that causes the recoil of the latter, and its weight and thickness enables it to withstand, what has been called the explosive ability, but the projectile, from its diminutive size and detachment, is incapable of offering opposition to the applied energy, hence its flight and subsequent destructive capacity.

NEW VIEWS OF MOTION.

407. It would appear from certain natural revealments, that to be in constant motion is an innate attribute of all ponderable and imponderable matter. In fact it may be positively assumed that every entity, whether of a gravitating or spiritous character, has an *intense inborn* propensity to seek change of place or mutation of position. There is likewise appertaining to the foregoing an eternal aptitude in bodies, to act and react the one upon the other, whether they are proximately situated or vastly remote, as regards the distance between them. It should be constantly borne in mind, that the *quantitive* interchange of action between bodies, is the same, be they near to or distant from each other, but not so their intervening *operative energy;* this quality increases in intensity as the separation lessens as regards the remoteness between each. In addition, it may be affirmatively announced, that without the existence of the foregoing properties, aided by the *continual* motion of the molecules making up gravitating matter, no natural or artificial economies would be developed.

The constant motivity of the particles of bodies, is assisted —as regards the inorganic world—by the ever undulatory activity of certain spiritous elements, as heat, magnetism, electricity, &c., which elements, in the vegetable and animal kingdoms, are intermixed, and their operation aided by particular life and spiritual existences.

(*a.*) *Inertia* (inactivity).—The ancients held it as a law of the material world, that all bodies were absolutely indifferent to a state of rest or motion, and would continue for ever quiescent, or persevere in the same uniform and rectilinear transit, unless disturbed by the action of some extrinsic energy, and they termed this property *inactivity*, *passiveness*, or *inertia.* The belief in this law has generally obtained, in the schools, up to the present day.

I am urgently impressed to reject as untenable the proposition as regards the *inertia* of matter, and must join Kepler,

who justly conceived that there was a disposition in all bodies to be in and likewise maintain their motion. I shall therefore hold that a state of quietude or negative condition, is not a contingency of ponderables or imponderables, but on the contrary I repeat that there is an *intense* propensity in all gravitating bodies to assume the most *vivid motion*, this propensity being aided by the spiritous principle that each carries in and upon itself.

Further, It may be also stated, that all matter—whether ponderable or otherwise—observes or obeys at least one universal law or proclivity, discernible throughout all mundane progressions, and this ordination is, that every ponderable material and its associated elements, will—when freed from certain obstructions—as well as assuming self-motion, must describe in its course, not a right line or a true circle, but that perfection of all movements, the ellipsoid, spiral or conical mode of advancement; in support of which theorem I quote the following.

1st. Oersted discovered, and Faraday demonstrated, that the electro-galvanic fluid performs a gyratory motion around the wires that conduct it. 2nd. Reichenbach states that his patients could see undulations assume a corkscrew-like course as they burst out of the magnet; my own patients also detected like characteristic vibrations constantly emanating from this apparatus. 3rd. A body projected into space and urged by a central energy, which varies inversely as the squares of the distance, must describe a conic section. 4th. All the planets move in ellipses or oval curves round the sun. 5th. Dr. Hook proved that the path of a moving body, would be an eccentric ellipse in vacuo, and an elliptic-spiral if the substance progressed in a resisting medium. 6th. Galileo asserted that the naturally uniform motion of bodies was that which takes place in an ellipse. 7th. The courses of the planets in their progression with the sun, are not in circles, but regular curves by *wavy lines*, such as our moon delineates in her orbit as she progresses with the earth; or as a nail in the tire of a wheel describes while it is turning round, and at the same time advancing. 8th. As seen from the sun, the planets would appear as though they formed circular orbits; but in space each actually moves in its own serpentine course, but the line never returns into itself. 9th. Kepler stated that the planets move in ellipses and not in eccentric circles and epicycles (circles within other circles) as taught by Copernicus. 10th.

If a drop of water be cast upon hot metal, it instantly assumes the ovoid form, and after an interval an elliptic motion of its particles may be observed, it then begins to revolve with rapidity, and evaporates slowly. 11th. It is this law of motion that produces the curved outline of the vegetable and animal kingdoms, causes the winding of rivers, shapes the waves of the ocean and air, and governs the tempestuous whirlwind.

(*b.*) *Touching the motive propensity of inorganic matter.*—Could we suddenly remove the earth with its influences from underneath any of the loose substances that crowd its surface, or fix our globe, without at the same time arresting its detached portions, we should instantly perceive these bodies start into motion and progress onwards in an elliptic serpentine course. I do not mean that this propensive result would be like that the equestrian experiences, where he flies over the suddenly stopping horse's head from the motivity given him by the animal's forward course, but the bodies in question would obey their innate propensity to seek change of place, independent of the earth's motion. To further simplify my proposition, suppose we could drop or cast a piece of rock into *space*, beyond the sphere and action of our system of worlds, and thus leave it free to exert its own inherent disposition, we should discover—if our vision might reach such an object—that it would instantly begin to describe a perfect ellipse or oval outline, resembling in its course an aerolite or asteroid (small planet) minus its perturbations from planetary and solar influences.

(*c.*) The innate disposition of bodies to vary their positions is illustrated by the gliding of glaciers, the spontaneous rotatory elliptic motion of icebergs, which renders them so dangerous to approach, and the sliding of portions of the earth, as witnessed in the so-called landslips. This last phenomenon ensues, in a greater or lesser degree, accordingly as the electrical prevails over the attractive magnetic conditions of the locality.

A tendency to self-motion may readily be discovered among the particles of organic matter, and under certain conditions, this disposition is observable relative to inorganic solids, and thus causes heated bricks, a piece of barley-sugar, the *iron* wheels of carriages, and the hearthstone before our fires to crystallise. Certain salts will often creep over the edge of the basin in which they have been dissolved, and even

advance along the shelf upon which the vessel is placed, mostly wending their course towards the light, like plants.

(*d.*) Relatively speaking, it may be positively asserted that there is no such quality as *rest*, or inactivity appertaining to ponderable matter, whether it be a world, a fragment of that world, or the molecules making up that fragment. This fact will be comprehended when we reflect that every object we behold is impressed with the ceaseless motions of the earth, accompanying as they do its varied movements. Thus our planet is known to journey round the sun at the rate of 68,000 miles an hour, or upwards of 1,000 miles a minute. It also rotates on its axis, at the equator, 1,042 miles every hour, further the orb of day travels in its course round alcyone 3,000,000 of miles every 60 seconds, accompanied, of course, by our planetary system.

(*e.*) The imponderable elements are ever in motion. Thus a current of magnetism is continually traversing the earth from pole to pole, as evidenced by the mariner's compass. All kinds of motion, and each change of temperature, give rise to electrical phenomena; hence our running rivers, the *never resting* tidal and undulatory ocean, the waves of the atmosphere, and, above all, the diversified transitions of the earth, with its momentarily varying sunlit-surface, must be fertile sources of unceasing currents of electricity, passing chiefly from east to west.

(*f.*) Further, as regards the tendency to self-motion. Pent-up fluids instantly begin to flow if we remove the obstruction that arrests the development of their inbred proneness to motivity. This sequence, by the general world, will be attributed to the law of *gravitation* overcoming molecular attraction. But sometimes liquids *ascend*, as in small tubes, or between the fibres of *dead* and living vegetables, and then an expression must be *coined* to suit the economy, termed *capillary* attraction; but where are the *hair-like tubes* to be found through which land is irrigated, or discovered, between the granules of certain substances where fluids are seen to rise as when we touch water with the inferior point of a piece of sugar. Very many of the explanations propounded by philosophical reasoners, are offered to hide their want of exact knowledge, and mean anything and nothing, so far as explaining the causes of certain incidents. Would it not be better to confess our nescience of the occurrences we cannot comprehend, and to merely state the facts as they arise,

rather than mislead the inquirer after knowledge? We know very little of the chain of *causation*, and we shall seldom be able to account wholly, if in part, for many of the effects we witness.

(*g*.) Heat and electricity readily rouse into action the innate aptitude of bodies to be in motion. Thus as regards caloric. It is known that boiling water will flow through small tubes, especially if they are *curved*, five times faster than when this fluid ranges at the temperature of 32° Fahr.; and alcohol runs six times more rapidly when raised up to 124°. If we apply heat to common water it loses the so-called property of gravity, and under the form of vapour rises upwards; and if we continue the application of caloric, ovoid steam-vesicles are generated, whose quality of self-movement, aided by the electricity that is always present in vapours, gives them an ability to burst the vessel that may control their motive propensity. Again, heat and electricity excite motive action in fluids under common temperatures, and produce in their vapours a disposition to form vesicles, which at certain pressures of the atmosphere, as on high mountains, become very much enlarged, as observed by Saussure after travelling on the Alps. He was astonished at the magnitude of the drops, as he first thought, whilst seeing them float slowly past him without falling to the ground. On catching some of these in his hand, he found that they were vapour bladders inconceivably thin.

(*h*.) Motion, like heat and electricity, when of a certain intensity, destroys what has been called the attraction of gravitation, as seen where bodies are rapidly rotating. If the revolution of the earth was 17 times faster than it at present is, the centrifugal ability at the equator would be just equal to the attractive energy, and bodies would exert no pressure or would be weightless. Motion imparted to bodies give them an ability that no pressure could produce. Thus the descending die imprints its image upon the metal with a fidelity and effect, that no ponderosity could give, nor yet the hand impress, if similarly applied to soft wax. The cogency of a moving mass will cause a punch to penetrate a thick plate of iron or a shears in motion to cut it, which no pressure could perform, and with as much ease as a needle could pass through, or a common scissors cut, a piece of paper. Thus momentum originates effects which are wholly distinct from weight.

(*i*.) The indwelling prosperity of materials to be in motion is displayed between certain separated substances and can be

sensibly effected, through the undulatory interchange of a series of special essences, which are always emanating from distinct bodies, as witnessed where the magnet acts and is reacted upon by soft iron, and also when electrically excited amber or sealing-wax developes motion in light substances. It is likewise exhibited in suspended materials where they arrange themselves either in polar or diamagnetic (pointing east and west) positions, as demonstrated by Faraday, whilst experimenting with galvanism, electricity, &c. Here he merely excited into operation the inborn predisposition of bodies to exercise their particular and natural propensities.

(*j*.) The subtile effective principles pervading ponderable matter—all things being normal—can never find repose, their inherent or general course of action,is to be always successively changing from one locality or position to another, and were they not sometimes redundantly accumulated or rendered intense, by isolation, either naturally or artificially, we should never have discovered their existence; for they would have gone on performing their ordinary mandate, as do at present many yet undiscovered essences pervading the existences surrounding us; whose separate or combined actions are still working out their economy, in and upon the constituents making up the world's system. And so they will continue, until propitious circumstances expose and time teaches us some of their artificial and natural uses, as it has already done by electricity, galvanism, and sound, &c. Many of the imponderable elements, because unseen or unfelt, may be deemed inert or passive, by reason of their simple or subdued action; but the amount of operation, though slight, is enough for the common or general purposes of Nature, and is *eternally* being employed in her economy as occasion or circumstances may require.

(*k*.) Nature at periods, by arousing one of the varied imponderable principles that pervade the substantive world—electricity for instance—into a vivid and intense exercise of its capabilities, may at times incite its correlative elements into a like condition, and now the series acting and reacting in concert, what special operations are effected by their conjoined and simultaneous energies! Similar results are sometimes effected by ponderable materials, as where we combine two or more simple bodies into one compound. The incorporation will be found to endow them with a series of novel abilities, capable of producing fresh and astounding sequences, especially when so situated that they can either display them spon-

taneously or be impressed to develope them by external excitants. Thus, charcoal, sulphur, nitrogen, and oxygen, employed separately, can exert a very feeble influence on their surroundings, but intermix them so as to form gunpowder, and now observe the result of their united action and reaction *inter se* when ignited. They will then be seen to endow the confined cannon ball with mighty energies, and to upheave the rock and tumble it into the valley. Again, nitrogen and chlorine are two simple gases and separately have little ability, but unite the two chemically, and excite them into action by motion, or the merest touch, and now a few grains of the mixture will split the mortar holding it, into pieces, as many ounces would crumble London into ruins, and a like number of pounds would, by their disruptive action convulse a world.

(*l.*) *Touching the flight of gun-discharged ammunition.*—This result is effected through the combustion of the powder, which, whilst burning rouses into intense activity the innate pyrogen or electricity that forms one of the constituents of ponderable matter, and of course the ball being by this agency freed from the earth's attractive magnetic influence, obeys its *inherent disposition* to be in motion, which motion it would continue, were it not obstructed by the air it rushes through, the earth's attractive sway, or the object it strikes against, to which latter it delivers the aroused electricity in question, that clings to it, calling forth in the body struck—by reaction—heat and sound, &c.

(*m.*) When a stone is cast from the hand, the effort made use of to accomplish this feat, causes the projector to burn or consume in his system a certain portion of carbon or muscular matter, thus setting free heat and animal electricity, which latter clings to the stone in question. This operation like the burning powder, overcomes the magnetic attraction of the earth for the thrown pebble, which now exercises its inborn propensity to be in motion, until the energy bestowed on it becomes absorbed by the air, &c., when the missile again obeys the magnetic influence of the earth and of course the projected stone falls to the ground.

(*n.*) *Constant motivity of the molecules making up solids, fluids, and gases.*—This economy may be readily conceived when we reflect that no two bodies, nor even their atoms, can possibly come in contact with each other. The reasoning philosopher well knows that there is nothing actually solid belonging to the material world, however dense that object

may be. The property of expansion and contraction appertaining to all things, proves the impossibility of their particles coming in actual apposition. The quality of elasticity, and a hundred other capabilities of bodies, whether simple or compound, could not be exercised if their atoms joined each other. Further, no vibrations could take place in materials if their corpuscles touched each other; consequently no sounds could be developed. The difference in the mobility of the atoms of solids, liquids, and gases, vary but in degree.

(*o.*) If the particles of a piece of metal, as frozen mercury, touched each other when in a solid condition, they must be separated to a greater distance, when the metal, by the addition of heat, became a fluid, and a still greater space must obtain between the molecules, as the mercury passes into a state of vapour. Water frozen into solid ice may also become a liquid and elastic steam, by applying to the denser mass and yielding fluid a certain proportion of caloric and electricity. From these facts we are forced to conclude that the corpuscles constituting the bodies which surround us, must be for ever separated from each other, for if they were in contact as regards vapours, they could not go closer together when forming fluids and solids. The monads of things can but touch each other in any sense of the word, and no mind can conceive their penetrating each other. It is, therefore, erroneous to suppose that we can, under any circumstances, come in positive contact, or be capable of touching the objects which surround us. Thus the hand when it grasps a substance, merely feels, or causes the nervous system to convey to the brain, and through it to the soul, the consciousness of a more positive existence of the being of a thing, than could be accomplished when the material was more distant. This sensational result, taking place as regards our organisation, is effected, as before observed, by means of certain undulations, which are ever issuing from, or out of, what in common parlance has been termed *matter*. Newton suggested that if he could remove, or abstract, all the motor fluid heat from out of the materials making up the earth, he would be enabled to place our globe, from its then condensed state, within the space of a small room.

(*p.*) Having established the fact that there are spaces between the molecules of bodies, we can readily imagine their freedom of motion; and as each has a polar property, and is surrounded by the elements of heat, electricity, magnetism, &c.,

we can easily conceive the fact of their continually revolving on themselves and around each other. This economy accounts for the changes continually taking place in all atomised entities, be they solid, fluid, or aerial.

(*q*.) The ever-rotatory motion of the corpuscles of which fluids are composed, is greater, and no doubt more rapid, than those of solids; hence their tendency to press in all directions, aided by the heat and electricity that enter, more or less, into the composition of all liquids. It is this condition of fluids that causes them instantly to start into motion, on the removal of the impediments which obstruct or hold them in check, as regards their propensity to seek change of place. (See *f*, sec. 417.)

(*r*.) *Relative to latent heat or the caloric of composition being the cause of fluidity and vaporisation.*—It is stated that "the molecules of fluids are more approximate, or nearer together than those of solid bodies, as shown by their incompressibility." This proposition rather contradicts the statement "that the attraction of gravitation (the tendency to resist separation) is increased as the squares of the distance lessen," for this being true in all its bearings, the particles of solids, as compared to those of liquids, ought to be most motile the one upon the other. But this difficulty is attempted to be got over by the employment of certain terms, as the "attraction of aggregation, or molecular adduction." The fact is, we at present are ignorant of the causes producing hardness and softness. The facility by which the particles of fluids move over each other, and the contrary as respects dense masses, are alike unknown to us, unless latent caloric, or rather the presence of innate heat and electricity of composition, be the agents producing the difference; for it is proved that if we apply sufficient artificial or non-chemical heat, the molecules of solids then easily and readily move over each other; and some of these hard bodies, like liquids, can, through the agency of extrinsic caloric, be caused to assume the state, or form, of vapours, as sulphur, mercury, iodine, &c., and thus they are made to approach the character of gases. This suggestion is borne out by the fact that fluids contain more specific or hidden heat than solids; and gases, by weight, more than fluids. Thus water possesses twice as much caloric as oil, 21 times more than ice, and 30 times as much as quicksilver or lead. Wherever density is increased, the capacity for holding heat is diminished. The quantity of caloric rendered latent where bodies pass from the

solid into the fluid state is enormous, as witnessed in melting ice; and to follow this result onwards, steam contains 900 degrees more hidden heat than boiling water, but the thermometer cannot measure its residence in the vapour, for in both it stands at 212° Fahr. In fact, this instrument cannot display the presence of the heat entering into the *composition* of bodies.

(*s*.) It should be noted that there are many different kinds of heat, electricity, and magnetism (see these Articles under their different headings), and each must, as well as changing in intensity, vary in quality, according to the source from whence they spring, or the condition of the bodies from which they may emanate. The elementary pulsating waves of these varying principles will, no doubt, in coming time, be recognizable and become divided, the one from the other, as colours, odours, and musical sounds are at the present day. Relative to the undulations of melodious *tones*, they are known to differ, according to the strings and character of the varied musical instruments from which they are produced, and they also deviate in quality, relative to the ability of the performer (see article "Sound") in relation to their curved *forms* and pulsatory type, or number of beats, in a given time. It has likewise been recognised that each tone, and even separate key, affects our nervous system differently, as do diverse colour-rays, or distinct odours. These last two elements are, in a degree, as *material* and effective as the spiritous rays of heat and electro-magnetic undulations.

(*t*.) There must always have been in existence the same quantity of heat, light, electricity, magnetism, &c., all of which, whether superficial or constituent—as regards ponderable matter—must be constantly displaying its effective operations, and therefore *can never be at rest*, such a condition, as regards these spiritous elements, could not obtain, without altering the whole face of Nature. Yes—motivity, is a fiat stamped upon all entities. If but one of these etherial essences became quiescent, or ceased to pervade the materials of which this globe is constituted, the whole series would become one boundless confusion of unimaginable chaos. It does not follow, however, that we can everywhere recognise the constant presence and activity of these subtile elements, from the want of means and apparatus whereby to display them to the senses Electricity was in active existence throughout every thing before Thales of Miletus, 553 B.C., Gilbert of Colchester, 1578,

and Franklin of Boston, 1753, arranged instruments whereby they were enabled to exhibit its being to our perceptive faculties and feelings. Magnetism existed in the rock, before its fragments were employed 20,000 years ago by the Chinese, as *leading stones.* Accident and opportunity teach us many things. We should have been wholly ignorant of motion, had we, like the zoophyta (plant animals) or crinoidea (lily-like spineless creatures) been reared on the rocks, in the tranquil waters at the bottom of the ocean. How unconscious of the existence of the matter of sound, would have been the animal creation, without the capability of motion, and that form and consistence of bodies, through which sonorous pulsations could undulate or vibrate. A piece of ice might be deemed, by the uneducated, to possess no caloric, but put it in motion and subject it to friction upon another piece of frozen water, and then enough heat will soon be elicited to melt the masses, though we perform the experiment in an atmosphere registering a temperature of 32° Fah. The heat developed by motion is never lost, its intensity and concentration may become altered, but its subsistence and motivity are eternal, which may be exemplified thus. Suppose two cannon balls of equal weight and size to be progressing, with like rapidity, in opposite directions, to meet and strike each other in their exact centres, they would be observed to recoil the one from the other or fall in a line perpendicular to their points of concussion, and here persons in general would conclude that the effects of the movements terminated, and so they have as far as the projectiles are concerned, but not so as regards the caloric developed by the impaction, that will be radiated into the adjacent substances, and from these the heat passes onwards to other objects, and will again, when called upon, be subservient to Nature's economy.

(*u.*) *Heat can call forth motion.* This ability may be witnessed where it generates activity in bodies, or that condition opposed to what has been in common parlance called *rest.* A potent instance of heat-ability is witnessed, when producing steam from water. Here, so great is the natural motive propensity increased by the operation of caloric on the particles of the *electric vapour* eliminated, that if we attempt to circumscribe their action, when of sufficient intensity, it is found that the substance of the most unyielding vessel will give way to what has been called the explosive energy.

(*v.*) It has at times been imagined by the unreflective, that

they, by particular processes, generated—whilst experimenting—some of the principles, pervading the substances they may have been operating upon. This supposition arose from the attention being mostly attracted to their own efforts and apparatus, never dreaming of the many elements and capabilities that lie hidden in the bosom of Nature. It escapes their cognizance, that when one of her springs is touched, a thousand others may be quickened and thrown into action, the one within the other, each of which, like the wheels and cogs of a watch, will, as economy requires, produce its quota of effect. The interlinked causes of natural events, we cannot perceive, and if we could, their mode of working would be beyond our comprehension. Every result, whether transpiring naturally or even articificially, is the consequent of a chain of causes, any one of the links of which being broken, no product could ensue. Thus, the machinery of the engine is generally supposed to be set in motion by the steam, but that could not have been generated without first producing heat by lighting the fire, and further, without the affinity of the carbon of the coal for the oxygen of the air, no electricity would have been eliminated by their union, which latter element acting on the levers of the mechanism, causes the progress of the apparatus.

(408.) *The undulatory properties of matter.*—The ancients, before the promulgation of the undulatory theory, supposed that all bodies *continually* threw off images, reflections or likenesses of themselves (see sec. 51), and these images they called sloughs or husks, which sloughs or skins they stated impinged on our persons, and made us sensible of the presence or existence of the things that surround us. The Germans in more modern times, likened these self-emanating images (which they also imagined to be continually thrown off from all substances) to the peels of onions or the natural coverings of things.

(*a.*) The eternally undulating *qualities* escaping from all substances, are some of them readily perceived, when sufficiently intense, as exemplified, 1st. By the radiating rays of caloric, that emanate from incandescent or red hot bodies. 2nd. The spiral *polar* magnetic undulations may be easily demonstrated, by acting upon a suspended piece of iron through means of a loadstone, or *vice versa* by influencing a pendent magnet by some ferruginous body. 3rd. There are likewise constant electric effluences appertaining to substances which, when rendered sufficiently intense may be recognised with facility. This increased energy is readily effected by friction of certain

bodies, as by rubbing a glass tube with some silken fabric, and afterwards bringing the vitreous cylinder—so excited—near small pieces of paper or pith-balls. The same result follows from the affriction of resinous bodies with woollen cloths. 4th. Added to the above, there are undulatory corporeal qualities emanating from objects, of which the organs of the brain, when perfect, readily take cognizance, as for instance, the waves constituting the spiritous material principle, designated *colours*, which the eye does not, nay *cannot appreciate* as evidenced in persons, the subjects of colour blindness (see secs. 117, 118, 119,) but are promptly estimated—according to, phrenologists—by a piece of brain, which they have called the organ of *Colour*. There are other distinctive undulatory qualities belonging to particular objects, which give certain phrenological developments the sense of fifth, *Size*, and sixth, *Weight* or resistance. These three brain organs are situated behind and above the eyebrows.

(*b.*) All bodies, as well as projecting their qualities, are constantly throwing off *images* of themselves (see sec. 51), which wake up in us the sense of their being. These qualities and corporeal representations are quickened, and consequently rendered more intense, when the different forms of bodies are more or less energetically acted upon by certain spiritous principles, as heat, magnetism, electricity, sound, and light. This last element, particularly whilst operating on bodies, renders the undulatory images of themselves and their properties more intense. This is the chief reason why we *feel* the presence of substantive things when they are under the influence of luminous rays, which we fail to do, *in our usual common condition*, when bodies are enwrapped in darkness. Further, the undulatory images and qualities of objects are rendered less intense or evident to our senses, the more distant they are from our persons. This result was evidenced under the old process of photography, or rather *iconography*. Thus, when employing the iodised metallic plate, the greater the distance of the things to be pictured were situated from the sensitive surface, the more faint or less effective was the impress, or engraving, of the subject *imaged*. Again, that these undulatory images are positively flung off from different bodies, is further evidenced by their deeply engraving themselves *into* these iodised plates, formerly used in the process of daguerrotyping, or protographing. This latter term is a misnomer, for the same process of engraving on sensative

plates can be effected in the absence of light, as when these plates, and even other impressionable surfaces, are placed opposite certain objects in the dark, a fact that was known long before daguerrotyping was discovered. It has often been demonstrated that we are able to produce portraits of persons and things on paper, through instruments that exclude so much light, that the sitter, or objects, are scarcely visible; and, in fact, when you cannot discern the details of the features and dress of individuals, or the outlines of the adjacent substances. The production of these pictures in the perfect absence of light, takes a longer period to effect the desired result. This fact shows that luminous rays are merely a hastener of the process in question, and not *the original cause*. Light only renders the undulatory images of things more intense, like the sunbeams enhance the action of the magnet, by rendering it more *effective* in its quality of sustaining a much heavier weight, especially if exposed to the solar luminary when the atmosphere is surcharged with electricity. There can be little doubt that it is the *actin*, or chemical ray found in the atmosphere, and especially pervading a beam of light, that so effectively *assists* the ever-undulating images in question, to print, or engrave, themselves on sensitive surfaces, and instead of calling these pictures photographic, or actinographic, they should be designated *iconographic*—that is, image-written, or image-generated pictures. That neither light nor *actin* are the originators of these pictures is evidenced by our being able to obtain them, even when the bodies to be imaged are placed *in vacuo*, opposite the sensitive surfaces, and the whole enwrapped in darkness.

(*c.*) In addition. A little reasoning might teach us that it it would be *impossible*, as regards the so-called sun-pictures, for light to produce the effects thus attributed to it. Reflected luminous rays, like other projected bodies or elements, must, when thrown upon a given object, act similarly to them, and can only leave their impress. It is impossible for us to conceive that reflected beams of light could by their own operation make any *permanent* recognisable mark, or engraving, on a given surface of the object from which they were thrown back. This being the case, it is evident that there must be something that escapes from *out* of the objects themselves that becomes pictured, and these emanations can write their images on certain sensitive receptives. Light, like *actin*, heat, and electricity, can only, as before observed, increase the

action taking place on the surfaces under discussion, and these subtle, substantive, spiritous principles, can, at most, only be *helping* agents as regards these results, and not the primary producers or causes of the effects in question. They may increase chemical action and incite operations in bodies already predisposed to assume changes; and this is all that can be conceived of their capability of action; unless they can be supposed to atomise the unparticled matter that exists everywhere, even throughout all space, and deposit it, thus corpusculated, on the surfaces under scrutiny.

(*d.*) *To rehearse examples of the constant motivity of ponderable and imponderable existences.*—The rivers of the earth are constantly flowing through their winding channels. The world of waters making up the mighty ocean, is *ever* rolling and heaving. Undulatory magnetism is *always* traversing in *spiral* lines from pole to pole, over and through everything that is in or upon our globe. Free electricity is *perpetually* pulsating through space and the earth's atmosphere, exciting into action the innate and surface electro-magnetic fluids that pervade both animate and inanimate existences, traversing the world's surface *chiefly* from east to west, giving rise to diamagnetism. All bodies are *incessantly* giving off, and in turn receiving, the radiatory spiritous matter of heat, which calorific rays vary in intensity according to the temperature of such bodies. Thus the streams of heat escaping from a piece of ice or cold iron, are much less vehement than those emanating from boiling water or melting metal. Lastly the celestial orbs of the great universe, are eternally revolving on their axes, and rushing in unimaginable swiftness around each other.

(*e.*) Motion, when artificially employed, can arouse certain spiritous principles, as electricity, heat, &c., into action, and produce effective changes or alterations in many things. Thus, continued agitation transforms the *black* sulphuret of mercury into the red crystalline sulphuret of this metal. Simple percussion imparts a crystalline character to the irregularly-arranged molecules of crude iron, as found in the wheels of the old railway carriages, which result rendered them so liable to fracture. Friction calls into activity evident electrical phenomena in many bodies. Flint and steel, when struck violently together, develope, or call into operation, 1,000 degrees of the spiritous matter of heat, which render points of the abraded metal incandescent enough to oxydise and burn them. Charcoal, flint, the pure metals, &c., are inert,

when taken or applied to the animal system, but they become very active medicines when triturated with some harmless body, as sugar of milk, or agitated with water, or spirits. Finally, it is the innate tendency of things to be in motion that gives rise to the *creation* and *preservation* of all animate and inanimate existences.

In conclusion, all the glories we behold appertaining to Nature, would disappear, and be replaced by unproductive stagnant confusion, if the inherent capability of developing or assuming spontaneous motivity was destroyed. It is certain inborn motive agents that give rise to all the energies which are exercised in and throughout the bodies and elements that everywhere surround us.

ELLIPTIC MOTION.

(409.) *Elliptic or oval motion.*—All hurricanes are gyratory —that is pursuing a curvilinear or ovoid course. These tempests or whirlstorms, blow in a determined direction, and advance along a curved axis from the equator to the pole. The reason why the barometer sinks during their persistence, is, that the superambient atmosphere becomes hollowed, like a bucket of water when rotated. During one of these whirlstorms, a ship—the Charles Heddle—once scudded before it for five days, and was impelled during her course in immense ellipsoid circles. The waves produced in water by the wind, have an ovoid outline, like the undulations of sound. The propagation of earthquakes—according to Humboldt—is generally effected by vibrations that observe a curvilinear direction, with a velocity, of 20 to 28 miles a minute, forming large ellipses, in which the undulations are disseminated with increasing intensity from the centre towards the circumference. Hurricanes, according to Lyell, sweep along at the rate of 90 miles an hour. Franklin relates, that he once saw, in Maryland, a whirlwind, which began by taking up dust, in the form of a sugar-loaf, with the apex downwards, it extended 50 feet high and 30 in. in diameter, and advanced in a direction *contrary* to the wind. Franklin followed this tempest and saw it enter a wood, where it twisted and turned round large trees with a vast energy. These were carried to a great height in a *spiral* manner.

(*a.*) The courses of the planets in their progression round the sun, are not in circles or regular curves, but in *wavy lines*, such as our moon describes in her orbital progression with the earth. The spiral nebulæ of the Milky-way, move in a corkscrew-like course, which economy gives them their alternate bright and dark streaks, as we contemplate their different sides.

(410.) *Spiral growth of plants and elliptic motions of their seed.*—In coiling stems there is a constant tendency to turn to

curious property is possessed by these setæ when the capsules (seed vessels of plants) are ripe. If the upper part of the spire is moistened, the capsule commences turning from right to left, but if the lower portion only is made humid, it turns from left to right. A remarkable instance of spiral structure connected with function, is seen in the peduncle (flower-stalk) of the female blossom of Valisneria, which is a water-plant. The female flowers spring to the surface of the water in summer, at the time the male blossoms have perfected their pollen (spermatic or seed granules) and scattered it upon the surface of the pond or stream. As soon as the pollen is conveyed to the female flower, its spirally twisted stem becomes contracted, and its fruit is perfected at the bottom of the water.

(*a*.) The cause of this ellipto spiral motive growth, appertaining to living things, is owing no doubt to a magneto-electric action. It is well known that electro-galvanic currents as they pass along wires, encircle them, after the manner of a cork-screw, as do musical *tones* when traversing the strings of instruments, or the undulations gyrating around elongated magnets (all humming sounds and noises that are void of this shape or outline are not musical tones. (See article "Sound.")

(*b*.) There can be no question that the magneto-electric fluids always flowing through the earth and air, preside over, and are continually permeating all living things, governing their every progressive function. The electro-magnetic undulations from the earth, that pass through and influence the living entities in and upon its surface, operate chiefly—as regards vegetation—on their earlier constituents, by passing through each tissue and their subsequent developings. The electro-magnetic currents of the atmosphere, have very probably most influence—relative to plants—when they have attained a certain growth.

(*c*.) Electricity and magnetism (see these Articles) are eternally pervading every living entity, and also govern the chemical economy of all inorganic existences. The positive and negative streams, appertaining to these fluids, gyrate—as demonstrated by Oersted and Faraday—around cylindrical objects in opposite directions, whilst traversing them, the one turning spirally to the right, the other twisting to the left, and whilst so doing they probably form nodes or intersections and bulging ellipsoid curves during their progression, which circumstantial results are readily detected, in regard to electro-

melodious tones, as they undulate around the strings of musical instruments. (See sec. 40.)

(*d.*) Query. As the negative and positive electro-magnetic streams—ejected from the earth and air—encircle the stems of trees and plants, may not the nodes of the ellipsoid curves that these currents form round them, influence the alternate production of their limbs, shoots, and petioles?

(*e.*) The cells of plants are *ovoid*, and within them are found deposits—presenting, the form of a more or less regular twisted fibre, winding within the cell from one end to the other, and this arrangement may present itself alike in cells of the ordinary configuration, or in fusiform (spindle shaped) folicles—constituting the proper spiral vessels—or in cells that have coalesced into continuous tubes or ducts. This tortuous fibre is very completely generated in some instances, when the cell-wall itself has not acquired any greater tenacity than that of mucus, very easily dissolved, which is a stage in the production of cells in general.

(*f.*) The Theory of the *spiral* development of leaves, &c., around the stem, is found to account for all the varieties occurring in their arrangement; and where opposite leaves, as in honey-suckle, or verticils (whorls) as in the strawberry, have been produced, they will again be rendered *alternate* or in a winding course, by any cause which restores the stem to its full development.

(*g.*) It appears that where there is determinate symmetry of form in the vegetable kingdom, it is of a convolute character. Now a spire or helix (coil) is evidently formed by the union of a circular and a longitudinal motion. The latter is usually produced in the young plant by the development of the axis; but where this is from any cause checked, a *circular* arrangement is the consequence. This tendency to spiral development is exhibited, not only in the arrangement of the leaves, &c., upon the axis, but sometimes in the form of the stem itself, as in the growth of climbing plants or in its internal structure.

(*h.*) Late investigations have shown that some animals, as the echinus (spinous sea-urchin), and asterias (starfish), &c., are developed, like plants, upon a spiral type. The usual direction of the spires of *shells* is from left to right; but there are some genera and species in which the contrary direction is occasionally taken.

(*i.*) The folds, or convolutions of the brain, with their

fibres—according to Gall—almost all assume a serpentine course; some form pyramids, whilst others run spirally.

(*j.*) In the Physa (a genus of fresh-water snails), the first movement of the yolk, as described by Owen, is one of rotation upon its axis; but as development proceeds and the ciliary (eye-lash like) vibrations are strengthened, the embryo begins to travel in an elliptic course around the interior of the egg, its two movements, to compare small things with great, resembling those of the planets.

(*k.*). The stomach rotates in its action, hence it forms *oval* hair-balls in the cow, and elliptic pellets in the owl. The egg, as it passes down the ovaduct, rotates in a spiral direction. According to Owen, the heads of spermatozoa (animal seed) are corkscrew-shaped, and always in motion.

(*l.*) The sporules (seeds of flowerless plants) of certain Confervæ (river weeds), at a particular period of their life, move about spontaneously inside the tubes in which they are generated, and at length they force themselves out into the water. These spores move about with great velocity in a gyratory manner. (See "Vegetable Motion.")

(*m.*) The sap of certain plants moves in a spiral course, as seen in the chard (a fresh-water plant); thus a number of globules pass up on one side, and turn round at the top of the cell, glide down the other, and are observed to again ascend.

(*n.*) Ovoid, or elliptic rings, may be evolved, or displayed, by putting smoke into a funnel, and then by covering the upper portion of the hollow cone with leather. On tapping this membrane with the finger, this operation will eject from the pipe of the funnel curved smoke-rings, which float through the air, like those produced by phosphoretted hydrogen, as it bursts out of the water, wherein this gas is generated. The smoke of the extinguished candle as it floats through the air, describes in its course curved ellipses.

(*o.*) Hogarth drew on his pallet the *contour of beauty*, which consisted of a serpentine-curved line.

(*p.*) A wire placed near, and parallel to, the conducting wire of a battery, has the polar condition of its molecules disturbed, and an induction propagated through it in an opposite direction to that in the conveying wire. If the conducting wire be twisted after the manner of a corkscrew, so as to form a hollow spire, or helix, it will be found in that shape to represent a *magnet*, one end of the helix being a north, and the

other a south pole, and, if moveable, it will arrange itself in a magnetic meridian under the influence of the earth's magnetism. Its poles are attracted by the unlike poles of an ordinary magnet, and it imparts magnetism to soft iron or steel by induction. Two such helices attract and repel each other by their different poles, like two magnets. Indeed, an ordinary magnet may be viewed as a body having a helical chain of its molecules in a state of permanent chemico-polarity. (Graham's "Chemistry.")

(*q*.) The foregoing facts prove that the spiral tissue of plants and membranes of animals are electro-polar, or magnetic; and as all bodies are rendered electro-magnetic by the induction of the earth and atmosphere, growing plants must have a stream of electro-magnetism passing up and down them, varying their course and intensity by day, as contrasted with that of the night, through the influence of undulatory heat and light, &c.

(411.) It is the property of all living organised beings, and essential to their existence as such, to be susceptible of the impressions of certain stimuli which occasion a reaction of the part stimulated. The muscular fibre in animals reacts, when excited, by puckering, called contraction, and this property is termed irritability. It is independent of the nerves of sensation, for a portion of a muscle, when removed from an animal, manifests the same contraction when irritated, whether mechanically, galvanically, or chemically. In the living animal, the most common stimulus of the muscular contraction is through the operation of the nerves, excited by the will, and is commonly the consequence of an act of sensation. In plants, universally, there are also irritable portions, which react, when stimulated, by producing motion of a part or the whole. It is this property which occasions the motion of the cambium or sap. It is from the same endowment that growing plants incline to the light, and extend their roots to the most congenial soil, or entwine their tendrils around the bodies which serve as their support; or move the stamen (male fertilizing organ of a flower) in regular succession towards the female part or pistil (as in saxifrage) or incline the pistil successively to each stamen (as in the lily). By a modification of the same irritable property, some plants close their leaflets or flowers at sunset, while others, like the nocturnal animals, go to to sleep as it were, at the approach of day. By a higher degree of this irritability the leaflets of the fly-trap (Dionæa)

approximate each other, and enclose the irritating insect which has alighted upon them, and the Mimosa pudica (sensitive plant) withdraws its leaves from the offending touch; whilst the Desmodium exhibits during the day a constant alternate movement of the lesser folicles (leaflets), analogous to the quicker vibration of the cilia (processes like eye-lashes) which bisect the respiratory organs of many molluscous (soft bodied) animals, and which is equally independent of the nerves and of the will, and would appear to be the result of an electro-magnetic action. The condition of these vegetable motions, which essentially distinguish them from the voluntary movements of animals is, that they never proceed from an internal impulse, but are invariably the consequences of an external stimulus, and take place, as it were, mechanically, or rather from an electro-magnetic action. In animals, the motions arise out of an internal determination from parts not moving, to the motory energies, or through animal magnetism. There is also an essential difference in the nature of the motion itself, even when we compare the simplest animal with the plant. If we touch the feeler of a polype, it recedes from the irritant by a true contraction of the part within itself; but in the case of the sensitive plant, there is nothing like this contraction of the portion touched, but is only an articular plication, or folding of a contiguous part, without the dimensions of the irritated leaf being altered. The simplest animalcule of infusions exhibits the voluntary characteristics of the animal, by varying its movements to avoid obstacles, or seize its food, while the locomotive embryo of the Confervæ dilatata proceeds blindly onward in an unvarying course, till its irritability is exhausted, and excites no idea of animality in the mind of an observer, who has had any experience as regards animalcules.

(*a*.) *Animal movements as governed by the nervovs system.*—Except in regard to the influence which injuries of the cerebellum (the small brain once *supposed* to preside over animal motion) exercise in the *medulla oblongata* (that portion of the sensorium that connects the large and small brain together) and spinal marrow, there does not exist, either in the state of health or disease, any relation between the cerebellum (Gall's organ of *Amativeness*) and the regularity of locomotive movements. Animals deprived of the cerebellum still enjoy regular locomotive abilities. The cerebellum of fishes, reptiles and birds, is more simple than that of mammiferæ (animals having breasts). Do the latter enjoy more regular or prompt

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NEW VIEWS

OF

MATTER, LIFE, MOTION,

AND

RESISTANCE:

ALSO

AN ENQUIRY INTO THE MATERIALITY

OF

ELECTRICITY, HEAT, LIGHT, COLOURS, AND SOUND.

To be Published Monthly.

BY

JOSEPH HANDS, M.R.C.S., &c., &c.,

Author of "Will-Ability," "Beauty and the Laws Governing its Development," "Homœopathy contrasted with Allopathy," "A Dissertation on Diets and Digestion," &c., &c.

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AND ALL BOOKSELLERS.

PRELIMINARY REMARKS.

It is intended throughout the forthcoming work to point out certain novel characters in regard to the influencing attributes of Matter—by displaying through particular facts—the true agency that the atomized and unatomized or ultragaseous worlds, exercise in the economy of Nature. Added to which, will be an investigation into some of the more abstruse Laws governing the various kinds of Motivity. Also an inquiry touching the action of the Life-Principle as it manifests itself, whilst governing the development of the vegetable and animal kingdoms. Further, the Materiality of Electricity, Heat, Light, Colours, Odours, and Sound, are considered, demonstrating that these principles have most of the characteristics of corporalities—save that of ponderability or weight. In addition, will be a disquisition touching the qualitative causes of Resistance, and lastly will be annotations on Geology and Astronomy.

LITERARY NOTICES.

We have been favoured with a perusal of a portion of Mr. Hands' Work on "Matter, &c.," and can speak of it as a most able and interesting contribution to scientific literature.—*The Modern Physician.*—May, 1879.

Mr. Hand's Essays on Matter, Motion, Life and Resistance, &c., are replete with instruction and original conceptions of a very striking character.—*Human Nature.*—June 20th, 1879.

Mr. Hands, of Hammersmith, author of some very interesting works, has now adopted the plan originated by Dickens and Thackeray, whose books were brought out in monthly instalments. Mr. Hands's views are most original and illustrated by facts, his language stimulates the mental taste, like that of Robert Burton and Dr. Johnson, and pleases whilst instructing the reader.—*The Sussex Daily News.*—June 18th, 1879.

Mr. Hands has issued the second (July) part of his "New Views of Matter, Life, Motion, and Resistance." In many respects, this thoughtful and industrious author has trodden paths which are also explored by Dr. Babbitt, in his great work on "Light."

These writers are pioneers in new fields of scientific research, and as such, a duty falls to their lot which cannot be attributed to a selfish motive. Mr. Hands is a true author, and gives to his readers profound original thought, at a popular price, his single object apparently being the education of the public mind in all its multitudinous forms.—*The Medium and Daybreak*, July 25, 1879.

abilities of locomotive action than the former? What relation is discoverable between the successive stages of development of the cerebellum, from the movement of birth to the 20th and 30th year, and the regularity of the locomotive movements? Are the mobile abilities of the man between 20 and 30 years of age more regular than those of the boy and girl from 5 to 15? Has it ever been proved that individuals possessing a large cerebellum, manifest more regular movements than persons in whom it is small? The cerebellum is more diminutive in women in general than in man, yet do females walk and dance with less regularity, art and grace, than men? Do castration and lesions of the testicles, which exert so vast an influence on the cerebellum, produce derangement in the regularity of locomotive movements? And what connection can be discovered between the regularity of these movements and the influence of lesions or diseases of the cerebellum on the genital organs? What have the painful tensions and heat of the nape of the neck, and the apoplexies of the cerebellum, so frequently associated with the sexual functions, in common with the regularity of locomotive movements? None of these questions is solved by the hypothesis that the cerebellum presides over muscular action. Irritations and lesions of the *medulla oblongata* and spinal marrow which *govern* voluntary motion, explain the irregularities of the locomotive movements which occur in these cases. To give a rational foundation to the idea that the cerebellum regulates locomotive movements, it would be necessary to show that the same proportion exists between the cerebellum and the ability, quickness, and regularity of these movements. But this proportion does not exist universally with regard to the *medulla oblongata*, the spinal marrow and the nerves which derive their origin from them. The ability, regularity and agility of the movements of the tiger, horse, boa, &c., are proportionate to the size of these organs in these different creatures, but not at all to the bulk of the cerebellum, which is smaller in them than in man.

(*b.*) A muscle may be *palsied* by some change taking place in the central organs, which shall prevent the nervous influence from being excited there. Thus by the effusion of blood in a certain part of the brain, the arm and leg, or the whole of one side of the body may be paralysed to the influence of the *will*. But the muscles which are thus withdrawn from the control of the will, may yet be moved by an emotional impulse, provided its connection with the parts of the nervous centres, in which

these actions are said to originate, be unimpaired. Thus a completely paralytic arm has been seen to be violently shaken when the emotions of the patient were strongly excited by the approach of a friend. The muscles of the shoulder in the case of paralysis of one side, were called into contraction in the reflex movements of yawning. And the muscles of the legs, when their communication with the brain—and consequently the control of the will over them—has been completely cut off, have been made to act energetically when the feet were tickled, although the patient was not conscious either of the irritation or of the motion. The energy of muscular contraction depends in a great measure upon the ability of the stimulus which is tramsmitted from the nervous system. Thus in the case of persons who are under the excitement of violent passion or insanity; a delicate female is often a match for three or four men, and can even break cords and bands that would hold the most powerful man in his ordinary state. The cause of fatigue, which comes on after prolonged muscular exertion, is really dependent upon a change in the brain, though usually referred to the muscles that have been exercised. For it is felt after voluntary motions only, and the very same muscles may be kept in *reflex* action, for a much longer time without any fatigue being experienced. Thus we never tire of breathing, and yet a forced voluntary action of the muscles of respiration causes fatigue. The voluntary use of the muscles of our limbs in walking or running, soon causes weariness, but similar muscles are used by madmen for days and nights together without exhaustion, and also by birds and insects, for very prolonged flights, without fatigue, and we find that the action of flying may be performed after the brain, or ganglia corresponding to it in insects has been removed. The energy of muscular contraction appears to be greater in insects in proportion to their size than it is in other animals. Thus a flea can leap sixty times its own length, and move as many times its own weight. The short-limbed beetles that inhabit the ground have an enormous ability, which is manifested both in their movement of heavy weights, and the resistance they overcome with their jaws. Thus dung-beetles can support, uninjured, and even elevate, a weight equal to 500 times that of its body. The stag-beetle has been known to gnaw a hole of an inch in diameter in the side of an iron canister in which it had been confined. The wings of many insects *strike* the air *several hundred*, and some small insects *many thousand times* in a second. The

eider-duck is said to fly 90 miles in an hour and the hawk 150. The swallow and swift pass almost the whole of the day on the wing. The flight of insects is more swift than that of the swallow, for this bird cannot overtake the dragon-fly.

(*c*,) The mind greatly influences the body. Thus the sight of a person in danger makes a greater impression on the system than the reading that thousands have been killed in battles. Natural language has a greater effect on the feelings than artificial signs, because the brain is thrown into more intense motion by passing events than those awoke up by memory or the relation of past occurrences.

(*d*.) It has been said that the contact of blood with the lining membrane of the heart stimulates its muscular walls to contraction as long as they retain their perfect structure and properties, even though the connection of that organ with the nervous system has been completely cut off. But there must be some other cause for the continuance of its regular movements, for the heart of some cold-blooded animals will continue to contract and dilate for many hours after it has been removed from the body. The heart of a sturgeon was extracted from this creature and inflated with air, but it continued to beat until the auricle (ear) had become so dry as to rustle during its movements. In the same manner the peristaltic move ments of the intestine continue to propel its contents for some time after the general death of the body, and even takes place where the whole tube is removed from it. These motions are partly the result of impressions left on matter, and are kept up or assisted by the electro-magnetic action of the earth and air, &c.

(*e*.) The heart is endowed with the property of *irritability*, by which is meant the capability of being easily excited to movements of contraction alternating with relaxation. Thus after the heart has been removed and ceased to contract, a slight irritation will cause it to execute, not one movement only, but a series of alternate contractions and dilatations, gradually diminishing in vigour till they cease. That the irritability of the heart is not dependent upon the cerebro spinal system, appears not merely from the manifestation of it when the organ is altogether removed from the body, but also from the fact that if the current of blood through the lungs be kept up by artificial respiration, the heart's action will continue for a lengthened period, even after the brain and spinal cord have been removed. Hence we see that the irritability of this organ

must be an endowment properly belonging to it and not derived from that portion of the nervous system. This action is much less speedily lost in cold-blooded animals than in warm; the heart of the frog will go on pulsating for many hours after it is removed from the body. The extraordinary tendency to rhythmical action which distinguishes the heart from all other muscles, is shown by the fact that not only do the entire hearts of cold-blooded animals continue to act long after their removal from the body, but even separated portions of them will contract and relax with great regularity for a long time. Thus the auricles will persist in their rhythmical action when cut off above the auricular ventricular rings, and the apex of the heart will do the same when separated from the rest of the ventricle.

(*f.*) The stimulus of the contact of blood with the lining membranes of the heart, to which its regular actions have been commonly referred, can have no influence in producing these movements; nor does it appear that the contact of *air* can take its place, since the rythmical contractions in the heart of a frog will continue *in vacuo*. Nor is there any evidence that the flow of blood through the cavities has the effect of securing the regularity of their successive contractions in the living body; for this regularity is equally marked in the contractions of the excised heart when perfectly emptied of blood, so long as its movements continue vigorous. But when its irritability is nearly exhausted, the usual *rythm* is often a good deal disturbed, so that the contractions of the auricles and ventricles (cavities of the heart) do not regularly alternate with each other, and one set frequently ceases before the other. The cause of these muscular actions must depend upon the electro-magnetic influences resident in their surroundings, which ever motive fluids are always acting on all organic and inorganic matter. (See " Impressions left on matter.")

(*g.*) The motion of the heart depends *in a degree* upon the sympathetic nerves, for we may remove the brain, and yet this viscus can be made to pulsate after it has stopped, by stimulating the spinal nerves, through their influence on the sympapathetic ganglia. You may divide the spinal nerves without disturbing the circulation; but a blow over the pit of the stomach often stops the heart, as will emotions, acting through the great sympathetic.

(*h.*) The epithelial cells of the mucous membranes are often seen fringed with *cilia* (hairs like eyelashes), they are always

in rapid motion, and waves pass across them, like those produced by the wind when sweeping over corn, and this continues after death. These epithelium cells have been seen to swim actively in water by the agency of their cilia for some hours after they have been detached from the mucous surfaces of the nose. This ciliary movement has been seen fifteen days after death in the body of a tortoise in which putrefaction was far advanced; and again in the gills of the river-muscle this action endures with a similar pertinacity. The purpose of this ciliary movement is to propel fluids over the surface, and is limited in the higher animals to the internal surfaces of the body, and always takes place in the direction of the outlets, towards which it aids in propelling the various products of secretion. The case is different among animals of the lower classes, especially those inhabiting the water. Thus the external surface of the gills of fishes, tadpoles, &c., is furnished with cilia; the continual movement of which renews the water in contact with them, and thus promotes the aeration of the blood. In the lower Mollusca, and many Zoophytes, which pass their lives rooted to one spot, the motion of the cilia serves not merely to produce currents for respiration, but likewise to draw into the mouth the minute particles that serve as food. In the free moving animalcules of various kinds, the cilia are the sole instruments which they possess, not merely for producing these currents in the water, which may bring them the requisite supply of food, but also for propelling their bodies through the liquid element. This is the case, too, with many larger animals of the class Acalepha (jelly fish), which move through the water, sometimes with great activity by the combined action of the vast number of cilia that clothe the margins of their external surfaces. Of the cause of the movement of these cilia, no account can be given. (There can be little doubt, I think, that these motions are the result of an animal electro-magnetic action.) A layer of ciliated epithelium, or cuticle, is found on the delicate membranes which line the cavities of the brain, and is also discovered in the terminal ramifications of the bronchial tubes and nasal cavities, and all other mucous surfaces, as the lining of the lungs, vagina, womb, and its fallopian tubes, &c.

(*i.*) The brain of man has been estimated to receive one-sixth of the whole amount of the blood, although its weight is not usually more than one-fortieth part of the whole body. This copious supply of blood has reference to two distinct

objects; first, to supply the necessary conditions for the action of the nervous system; and, secondly, to maintain its *nutrition*. Many circumstances lead to the conclusion that in the nervous, as in the muscular system, every vital operation is necessarily connected with a certain change of composition, so that no manifestation of nervous ability can take place unless this mutation be effected. There is reason to believe that this change essentially consists in the union of oxygen, or some other principles, conveyed by the arterial blood with the elements of the proper nervous matter, and that this union consequently involves the death and disintegration of a certain amount of nervous tissue, the reproduction of which will be requisite, in order that the system may be maintained in a state fit for action.

(*j.*) The fibrine of the blood is in perfect *solution;* but this fluidity does not depend on motion, as seen by including it between ligatures; but if we break up the brain and spinal cord it soon coagulates, because we here cut off the nervo-magnetic current through it.

(*k.*) *Combustion, or creation of carbon during muscular action.*—A humble-bee has been found to produce one-third of a cubic inch of carbonic acid in the course of an hour, during which its whole body was in a state of constant movement from the excitement consequent upon its capture; and yet during the 24 hours of the succeeding day which it passed in a state of comparative rest, the quantity of carbonic acid generated by it was absolutely less. A man produces, or consumes in the lungs, 7 ounces, a woman 5 ounces, and a boy and girl, aged 10 years, 4 ounces of carbon, or charcoal, in 24 hours. Very old and young people burn little charcoal either in the skin or pulmonary organs, hence they soon become fatigued.

(*l.*) *Reflex (directed backwards) motive actions.*—If the head of a centipede be cut off whilst in motion, the body will continue to move onwards by the action of the legs, and the same will take place in the separate parts, if the body be divided into several distinct pieces. After these actions have come to an end, they may be excited again by irritating any part of the nervous centres, or the cut extremity of the nervous cord. The body is moved forward, never backwards. If the body be opposed in its progress by an obstacle of not more than half its weight, it mounts over it, and moves directly onwards as if in its natural state; but if the obstacle be equal to its own height, its progress is arrested, and the cut extremity of

the body remains forced up against the opposing substance; *but the legs* will continue to move. A water-beetle having had its nervous cephalic ganglia removed, remained motionless so long as it rested on a dry surface; but when cast into water it exercised the usual swimming motions with great energy and rapidity, striking all its comrades to one side by its violence, and persisted in these movements for more than half an hour.

(*m.*) The ostrich pursued its course after decapitation by the crescent-headed arrow of the Roman emperor. The decapitated cock of Boerhave ran on in the direction towards its food, previously impressed by its volition, each successive contact of the foot with the ground exciting the subsequent movement. The tail of the lizard will leap about for some time after it has been suddenly torn off.

(*n.*) The embryonic mass in the ova of the gasteropoda, turns on its axis during a great portion of its period of development, but not from having cilia, this economy ensues also with Polypes and Tunicata (headless Mollusca).

(*o.*) Dr. Ure in his celebrated experiment upon the murderer Clydesdale, produced, by means of electricity, on the dead but yet warm corpse, a horrible caricature of life, by calling into violent contractions the muscles of the face, all the expressions of rage, hatred, despair, and horror were depicted upon the features, producing so revolting a scene that many spectators fainted at the sight. These results prove that the phrenological organs of the brain, by means of animal electro-magnetism conveyed by the nerves, can exhibit *their true character* whilst acting on the muscles of the face.

(*p.*) The motivity of the blood in the capillaries (hairlike-vessels) is greatly aided by animal electricity. It has been proved that if a receptacle containing water, having a very small hole in its base, be connected with a prime conductor of an electric machine, the water will merely escape by drops, but on setting the machine in action, the particles of the fluid will now run in a continued stream.

(*q.*) *Action of the will and nervous fluid in regard to muscular motivity.*—If two covered vessels precisely alike, the one empty the other full of leaden bullets, be placed before a person, let him first lift the full one, and then be told to raise the empty vehicle—with an understanding that it is of equal weight—he will put into the second effort so much unnecessary energy, from the expectation of being about to lift a great weight, that his baffled exertion will, in its reaction, cause qnite a painful

VEGETABLE VITAL MOTIVITY.

412. *Vegetable vital motivity.*—The phenomenon of an inclination to successive change of place is most recognisable among the compound granules of organised existences, as in the red globules of the blood of animals, and the active molecules of plants. As regards the motive particles of the vegetable world, they are extremely minute and *ovoid* in form. These granules are found in all vegetable matter, when rubbed into small portions, and examined by the microscope. They are perceived to have a rapid motion of an undulatory or oscillating gyratory character, so that a drop of fluid in which they are placed seems to be, as it were, alive. These molecules are most numerous, and of a large size, in the pollen-powder found on the anthers of flowers; and, as regards plants, are the spermatic granules, through the agency of which fertilization takes place. The movements of these particles do not cease with the life of the plant, for they have been seen by Dr. Brown in the fossilised remains of vegetables. They are readily detected in green gamboge when dissolved in a liquid. The particles thus set at liberty instantly commence their motion. They lie dormant in our furniture and the wood of buildings, but are capable of immediate motion when set at liberty. They lose the ability to move, and *apparently* their separate life, when combined by the irresistible laws of Nature into other beings of a more complex structure, but still, as it were, forming life. Their apparent vitality does not cease with that of the object with which they have been combined, but continues through vast periods. Their *original propensities* to be in motion are restored the instant they are liberated from their prison, for Dr. Brown caught them in minute globules of almond oil, and imprisoned them for weeks, but without interrupting their motion.

(*a*.) Mr. Travers observed isolated blood-globules enter the capillary tubes and perform an oscillatory movement in them for hours, before any series of them passed into the animal circulation.

(*b*.) The passage of juices through the leaves and stems of plants, and the vessels of animals, designated respectively the sap and the blood, &c., owe much of their motivity to an *innate propensity* to be in motion. The gesticulation and progressive movements of animals are, in a measure, derived from this inborn tendency. The motive energies exercised by living creatures, are not alone the result of will-ability, or the application of the nervous stimulus, these are in a degree helping agents, which serve to rouse into activity the magneto-electric fluids of the body, which, acting on the muscles, and these again on the bones and cases of animals, enable them to obey their *inborn* inclination to wander, or adapt their economy to changing circumstances. The plant displays, in some of its parts, a similar *innate* motive disposition to that of the animal kingdom; but a certain number require an external irritant to be applied, when they instantly exhibit this inherent propensity to become in a state of motivity, as witnessed in the sensitive plant, the venus fly-trap, and our native sundew, found in the bogs of this country.

(*c*.) *Vegetable irritability*.—This quality approaches almost the manifestations of life as seen in animals. Thus, on the banks of the Ganges there exists a botanic form, so life-like as to resemble some of the lower animals in its motions. The Desmodium Gyrans will not move but when placed in a position where the temperature approaches 100° Fahr. (In this particular, plants display a like requirement to that of inorganic bodies, where heat is found necessary to sensibly develope their disposition for activity, and other economies, as seen with regard to the melting of ice to form water, which fluid is known to be always in motion, though apparently at rest. This fact is proved by placing at the bottom of a vase filled with water certain colouring matters, which after a time become diffused throughout the whole aqueous liquid by the imperceptible currents always taking place in every fluid. Again, steam requires heat and electricity to develope its energies.) But to resume, the leaflets of this Desmodium Gyrans are in perpetual agitation; one of them erects itself by a succession of gentle starts, so as to mount about fifty degrees above the level of the petiole, and then fall in like manner. While one rises another is descending to about the same distance; and so the movements continue. These transitions do not cease at night, and in the still hours of an Indian summer evening they are very active. The restlessness is

more vigorous in the shade than in direct sunlight. The sensitive plant requires in our climate artificial heat for the development of its motive phenomena. To the traveller across the warm plains of Senegal, the "good-morning" flower, or "how do you do" plant, as the natives in their language call it, as if it offered a friendly salutation, by bowing as they pass by it, is an attractive and wonder-creating object. In some other plants the stamen may be excited into motion by irritating it with a needle.

(*d.*) The Oscillatoria among the Confervæ, have green articulated filaments, deriving their name from the oscillatory motions observable in them. These plants not only move their limbs, but shift their station with rapidity, and this *independently of light* and heat, or any other perceptible agent, for these actions take place in the dark, and ice-cold water.

(*e.*) The minutæ, oily and amylaceous (of the nature of starch) molecular matter that is suspended in the fluid which contains pollen-grains, moves with great activity, each particle upon its own axis; and this action has often given rise to the idea that these molecules were of an animalcular nature.

(*f.*) The presence of yeast, or that of any gluten-like material excites in saccharine fluids an *intestine motion*, by which, if there be sufficient yeast, the sugar is resolved into alcohol and carbonic acid.

(*g.*) "Without entering," says Humboldt, "on the difficult question of *spontaneous motion*, or, in other words, on the difference between vegetable and animal life, we would remark that if Nature had endowed us with microscopic capabilities of vision, and the integuments of plants had been rendered perfectly transparent to our eyes, the vegetable world would present a very different aspect from the apparent immobility of repose in which it is now manifested to our senses. The interior portion of the cellular structure of their organs is incessantly animated by the most varied currents, either rotating, ascending, and descending, ramifying, and ever *changing* their directions, as manifested in the motion of the granulated mucus of marine plants—as in the naiades, characæ, hydrocharidæ, and in the hairs of phanerogamic (having the productive organs visible) land plants; in the molecular motion first discovered by Dr. Brown, and which may be traced in the ultimate portions of every molecule of matter, even when separated from the organ where it was generated, also in the gyratory currents of the globules of cambium

(glutinous liquid of plants) which glides in circles not rotatory and circulates in peculiar vessels in the antheridia (anthers) and of the chara and the reproductive organs of liverwarts and algæ (sea weeds, &c.), the structural conditions of which Meyen believed to bear an analogy to spermatozoa (animal seed of the creature kingdom). If to these manifold currents of gyratory movements we add the phenomena of endosmosis (the attraction through a membrane, of a thin by a denser fluid), nutrition, and growth, we shall have some idea of these energies which are ever active amid the apparent repose of vegetable life."

(*h*.) Locomotion may be seen in the reproductive particles or spores of certain Confervæ. At a particular period of their life, these spores move about spontaneously inside the tubes in which they are generated, and at length force themselves out into the water, wherein the mother-plant is floating. Once plunged in this element, the spores move about with velocity in a gyratory manner, till they reach a shaded place, when they fix themselves by one end, produce a root, and then lose all ability of after motion.

(*i*.) With the unfolding and closing of flowers, must be arranged singular motions in the parts of fructification which occur on their being touched. Thus, if the filaments of berberry are irritated, they rise up and strike the anthers against the stigma on the style; if the finger be applied to the sexual column of the plant stylidium, which is bent over to one side of the flower, it swings round instantly to the other side. Several cases of this ability of motion occur in the Archidaceæ; if the caudicular stems of the pollen masses of the plant Catasetum are disturbed, it springs up so violently as to separate itself from the column on which it grows and darts to a considerable distance. A very singular character of motion in flowers of another plant of this kind—growing in Swan River Colony—has been described by Mr. Drummond. The lower lip, he says, in which the anthers are placed, is a boat-shaped box, the upper lip, which he supposes to be the stigma, forms a lid, that exactly fits it, the hinge on which the lid moves, springs from the upper part of the flower, and is attached to the centre, and when it opens the superior portion moves round within the box, comes out at the bottom, turns up and back, so that when fully expanded it stands fairly over the flower. The moment a small insect touches the point of the lid it makes a sudden revolution, brings in the point of the

lid at the bottom of the box, so that it has to pass the anthers in its way, and makes prisoner any insect which the box will hold, and having caught it remains shut while the animal moves about, but if the insect be not caught, the box soon opens again.

(*j.*) With the Aimeria in the flowering season a short column below the stigmata lengthens, so as to close the foramen of the ovule (a rudimental seed) and at the same moment, the cord on which the ovule is suspended slips aside and elevates the ovule, so as to enable it to present its foramen to the column. The same phenomena are visible in Daphne Laureola and other plants, and something of an analogous nature occurs in Zygnemata, which at the period of fructification bring themselves together, and effect a kind of spontaneous vegetable copulation.

(*k.*) In the Asclepiadaceæ, which have the pollen grains closely packed in bags, from which it would seem there is no escape: at the period of fecundation, each of the pollen grains projects one tube from its side, and those tubes all direct themselves spontaneously towards a thin space on the side of the bag that holds them. Piercing this bag, they succeed in extracting themselves and reaching the vicinity of the stigma, but are still at some distance from it, they then direct their course towards that organ, and succeed in reaching it, where ever it may be, either by directing themselves at right angles, or downwards, and even upwards, as the peculiar structure and location of the stigma may require.

(*l.*) The sleep of the leaf, that is, their folding up and drooping at night, and their raising and unfolding themselves by day, are capabilities of motion in the limbs and stems of plants, which are doubtless of the same nature as that of the sensitive plant and its allies. To the same class also must be assigned the fly-catching Dianæa: this plant which grows wild in the marshes of Carolina, has a leaf which is bordered with a row of strong teeth, and when spread open is strikingly similar to one of the toothed iron traps when set, as used for catching game, that is, it consists of two roundish sides, each furnished with a row of strong teeth, near the middle of each side there grow three stiff bristles, placed in the form of a triangle; if one of these bristles is touched by an insect or any other means, the two sides of the leaf spring up instantly, the teeth cross each other, and the insect is held so fast that it can only be extracted by forcing the sides of the leaf asunder, an

operation of some difficulty, so great is the energy with which the contraction is effected.

(*m.*) *Vegetable movements in regard to their seed.*—The Balsam termed *impatiens noli me-tangere* (impatient touch-me-not) has a seed vessel or capsule, formed of five divisions, which when the seed are ripe, suddenly separate from each other and curl inwards, scattering the seed to some distance. The squirting-cucumber, when ripe, very readily separates from its stalk, and then its pulpy contents are violently forced out from the aperture thus left.

(*n.*) *Vegetable contractility.* — Some of the movements of plants depend in a measure upon their property of contractility, by which they are enabled to shorten their tissues upon the application of a stimulus, resembling in a degree the muscular fibres of animals. Thus, if the leaves of the common wild lettuce be touched, when the plant is in flower, the part will be covered with milky juice, which is forced out through the stomata (the *oval* holes in the covering of plants, and the scarf-skin of animals) by the contraction of the cells or vessels beneath. Again, in the flower of berberry, if the base of the stamen be touched by a pointed instrument, the filament or stalk will bend over so as to strike its top against the style or central pillar of the flower, thus causing fertilisation. This is seen in the New Holland plant Stylidum, which has a tall column rising from the centre of its flower, and consisting of the stamen and style united, this usually hangs over the side of the flower; but if it be touched ever so lightly it starts up with a jerk, and rapidly swings over to the opposite side.

(*o.*) Some of the coloured globules that give the hue to the *latex* or vital fluids of plants are seen to oscillate in this vegetable product, which when separated from the plant coagulate, and leave a fluid lymph or serum. The latex seems to bear the same relation to the system ol the vegetable that the blood does to that of the animal, and to be the immediate source of the various secretions of the vegetable world.

(*p.*) The bamboo grows 150 feet in a season, and it is stated that you may sometimes see or be conscious of its upward movement.

(*q.*) *Electro polar state of the vegetable kingdom.* Herr von Kielmeyer supposes that there is acting on plants, a principle the analogue of magnetism and electricity, which, polarizing the cells of which a vegetable is composed, give to one set an upward, and to another a downward growth.

MOTIVITY AND CIRCULATION OF ANIMAL FLUIDS.

(413.) The heart is *presumed* to be the central organ of the circulation, and by its alternate contraction and dilatation is supposed to exercise the principal energy by which the blood is propelled through the systems of the higher animals. Its anatomy and physiology become intelligible by considering first the principal varieties of the circulation or rather motion of nutritive fluids which occur in the animal kingdom; bearing in mind that the main objects for which such a motion is required are a constant supply of fluid adapted for nutrition to all parts of the body, and its regular exposure in land and some sea animals to the influence of the air by the process of respiration, &c., through the lungs, and also—in aerial creatures—the skin, so that it may be fitted for maintaining the life of the animal. The simplest mode by which a distribution of nutritive fluid is effected by means of ramifications proceeding from the stomach and intestinal canal to various parts of the body, is that which occurs in the polyps, infusoria, entrail worms, medusæ (jelly fish), and zoophytes (vegetable animals). In all these the digestive canal and the circulating system form but one apparatus. The food, which in the higher animal requires a complicated process of assimilation before it is fitted to move with the blood, is in them already adapted for nutrition. In most of them currents can be seen passing in opposite directions along the canals opening into the digestive cavity, exactly like those well-known to exist in the stems of charæ (plants found in salt and fresh water, whose fluids are always rotating and probably produced by the motion of ciliæ (eyelash-like filaments) which line the tubes, but they are too minute to be discerned with the microscope. In the planariæ and some of the trematoda a separate vascular system has been discovered in addition to the ramified digestive tubes. In the former the main trunk has the shape of an oval loop from which capillary networks arise and communicate freely together, and with a median dorsal vessel. These vessels have been seen contracting

and dilating, but no regular course of fluid has yet been discovered. A more perfect form of circulation of this kind is found in the anellides (the worm tribe) and in the leech. There are two main lateral vessels communicating at their extremities, and by transverse branches with each other, and with a third central vessel which contains within it, bathed in its blood, the nervous cord, and present knot-like swellings at the same situations as that cord does. Alternate motions of the blood may be seen in these vessels, at one moment the lateral vessel and the central with the communicating branches between them are seen filled with blood, while the other lateral vessel and its branches are empty. During the contraction of a lateral vessel the blood evidently flows from it through the middle transverse vessels over to the other side, and the next moment returns. The contraction proceeds from behind forwards, so that a wave—as it were—of blood is seen passing from one end of the lateral and of the central vessel to the other, and then returning in the contrary direction through the other lateral vessel. In this manner it is probable that a constant circulation is maintained along the sides of the animal and its direction seems to be changed after every eight or thirteen pulsations. The same general type of circulation is found in earthworms and all other anellides.

Hitherto nothing has been seen, which could be called a heart, nor have the vessels presented any character by which they could be separated into systems of arteries and veins, for all alike seem to perform, at different times, the functions of both. A more distinct division of the parts of the circulating system is found in insects. They have a large vessel running along the back divided by numerous constrictions into a series of communicating cavities, between these are lateral openings through which the blood is received, and these are guarded by valves to prevent the blood from flowing out. Through this, which is called the dorsal artery (but it may rather be regarded as a series of ventricles) the blood passes from behind forwards, diverging into small streams, one of which flows to each of the antennæ (feelers) and feet, &c. No distinct vessels can be detected in which these minor currents may run, they seem simply to pass through the various tissues, and having arrived at their destinations, to form there into arches, and return and empty themselves into the abdominal vessels, which may be regarded as veins, and through which the blood flowing from before backwards is returned into the dorsal artery through the

communications which exist between them at the posterior part. This plan of the circulating system, with various modifications, prevails in the arachnida (spiders, mites, and scorpions) and the lower crustacea (having a shelly coating or crust).

(*a.*) Harvey considered the heart to be the sole agent by which the circulation is effected, but it is certain that several other causes exercise auxiliary sway. The veins, like the arteries, have at times been seen to pulsate, and the pulsations have been clearly proved to have been communicated from the heart through the capillaries, whilst it may added that the rapidity of the current in the arteries, veins, and capillaries is always in direct proportion to the strength and frequency of the ventricular contraction, and always more rapid in the parts near, than in those remote from the heart. It ceases in all, the instant the heart is removed, or its influence on a part cut off by dividing the main artery. In old persons in whom the whole arterial system of the legs is sometimes ossified and rendered incapable of contraction, the heart alone is sufficient to maintain the circulation through these parts. The heart acts as a forcing and sucking pump. During the circulation of the blood there is a constant stream running through the vessels, and at every contraction of the ventricle of the heart, an impulse is given to that part which is next the heart, producing a wave which is propagated rapidly through all the arteries, and causes at each part of them a slight dilation as it passes within them.

(*b.*) The capillaries (hair like vessels) are the most delicate of all organic tissues, measuring from $\frac{1}{2000}$ to $\frac{1}{6000}$ of an inch in diameter, they exist in all tissues of the body, varying, as regards arrangement, only in the greater or less closeness of the network that they form ; and of which the meshes are in some organs so fine as not to exceed in width the diameter of the capillaries themselves, as is the case in the iris of the eye, and in the substance of the lungs. It is through these vessels that all the important processes of secretion, nutrition and absorption are effected.

(*c.*) The influence of the minutest arteries, veins, and capillaries, on the circulation, is best seen in the phenomena of local action as inflammation, blushing, turgescence, or swelling, &c. If the web of a frog's foot—placed in a microscope—be irritated, the capillaries are seen slowly contracting, so as sometimes to prevent the flow of blood through them, and if the

stimulus be so great as to produce inflammation, then they dilate and a large number of globules is seen passing along them with great rapidity. The same may be seen in the human eye, the vessels in front of which are so minute that they give no colour to it; but if they be irritated by a particle of dust, at once they dilate and the red blood globules entering them, are seen as tortuous canals filled with blood. On a larger scale we perceive, after a wound or other injury, the parts around grow redder, and swell from the afflux of blood to its capillaries, and if the inflammation arise in a part which can be compared with another similar one as in the hand, one feels that the pulse is fuller and stronger on the injured, than on the sound side, indicating that a larger quantity of blood is passing through it.

A still more evident accumulation of blood is shown in blushing, in which, from the *mental* impression, in an instant all the minute vessels of the face, neck, head, &c., become distended with blood. The paleness of fear is produced by the opposite condition, and we have other cases in which a decrease of the quantity of blood in a part is seen as in deficient nutrition and shrinking of parts which have become useless, as in the gills of tadpoles, the horns of deer, &c. All these circumstances prove that, independently of any influence extending from the heart or arteries, there is in the very minute vessels of all parts an ability by which the supply of blood passing through them may be either increased or diminished, whether it be effected by an alteration in the propelling ability of the vessels themselves or from an electro-magnetic influence, and an innate disposition to be on the move.

(*d.*) The veins, like the arteries, are elastic, and this ability is occasionally exerted in recovering them from too great distention; they also have a vital contractility, the influence of which is remarkably shown in their shrinking when cold is applied.

(*e.*) In the lowest animals, the movement of the circulating fluids seems as independent of any central organ of impulsion, as it has been shown to be in plants. Thus in the living sponge, a current of water is continually flowing through the tubes and channels, by which its substance is traversed, the fluid being taken in by the small orifices, and ejected in energetic streams from the large ones, and yet the most attentive examination has not revealed any mechanical cause for the movement. In some of the compound polypifera, a similar current may be seen and it is curious that, in many species, its direction undergoes a

periodical change, being reversed at intervals of a certain number of seconds. In the star-fish and sea-urchin tribe, a complex circulation of blood takes place through regular vessels; and here we find some indication of a contractile cavity. In the articulated series, there is, with a few exceptions, an absence of any central organ of impulsion, possessed of an ability sufficient to carry the blood through the vascular system. In the aquatic worms the movement of the blood, and the pulsation of the dorsal vessel shows that the current is not propulsive.

(*f*.) The blood continues to flow through the capillaries in cold-blooded animals after the removal of the heart, and by the arteries being found empty after a natural death in the higher animals, is a proof of the contraction of these tubes also —for when an animal is killed by *electric lightning*, the arteries are found to contain their due proportion of blood.

(*g*). It has been well ascertained that a real process of secretion continues after death: thus urine has been poured out by the ureters, sweat exudes from the skin, and the hair grows, &c. These changes could not have taken place unless the capillary circulation were still continuing. In the early embryonic condition of the highest animals, the movement of the blood seems to be unquestionably due to some *diffused ability*, independently of any central impulsion; for it may be seen to commence in the vascular area before the development of the heart. The first movement is *towards*, instead of *from*, the centre: and even for some time after the circulation is fairly established, the walls of the heart consist merely of cells loosely attached together, and therefore can have no contractile energy.

(*h*.) In the fœtus (child in the womb) the capillary ability supplies the place of the heart, up to the period of birth. It has occasionally been noticed that a gradual degeneration in the structure of the heart has taken place during life to such an extent that scarcely any muscular tissue could at least be detected in it without interruption to the circulation, as must have been anticipated, if it furnished the sole impelling ability.

(*i*.) In certain of the lower tribes of animals whose locomotive abilities are feeble, and general habits inactive, the circulation of nutritive fluid is carried on nearly in the same manner as in plants. There is no central organ for propelling it through the vessels, and ensuring its regular and equable distribution; and its motion must depend upon the energies

created in the individual parts themselves, by animal electro-magnetism, and the innate propensity to be in motion. In some of the infusoria, according to Ehrenburg, a distinct set of reticulated vessels may be seen, channeled out beneath the surface, in which a movement of fluid may be perceived, independent of any perceptible impulsion, and apparently similar to the circulation of the elaborated sap in the intercellular passages of plants, which is propelled onwards by the electro-magnetism of the earth and atmosphere.

(*j*). The heart cannot be the only means by which the motion of the blood is continued, for the changes which this fluid undergoes in the capillaries show they have a share in its production; it is their continued action that assists to empty the large vessels after the systemic circulation ceases. The capillary circulation often continues in a severed limb for a time, if it be kept warm. The circulation in living animals discloses many irregularities in the capillary currents which it is impossible to attribute to any influence derived from the vessels that supply them; thus the velocity of two currents in neighbouring channels is often very different, their direction changes, and some of them even occasionally stop and recommence again without any perceptible mechanical cause. Some other arguments for the independent nature of the capillary circulation may be drawn from the spontaneous motion exhibited by the globules of the blood, when removed from the body, or liberated from vessels. In the development of the embryo of the higher vertebrated animals, there is a period at which a distinct movement of red blood is seen before any pulsating vessel can be detected to possess an influence over it, and in the formation of new membranes, which is one of the results of inflammation, the lymph at first poured out in a fluid state and gradually acquiring a solid consistence, presents channels in which globules are seen to move before these became connected with the vessels of the neighbouring parts.

(*k*.) Dr. Thomson and Van Boer state that there can be no doubt that the blood is formed *before* the vessels. The creation of the blood goes on in every part of the body, and when formed it is put in motion by some unknown cause that impels it in its proper direction (the cause is from an innate propensity to be in motion, assisted by an electro-magnetic action which presides over, or assists all and every kind of motivity) until at length it reaches the central formation of

blood, around which is developed a tubular canal, afterwards to be further modified and changed into a heart. The first motions of the blood are towards the heart, and consequently the first vessels formed are *veins*, a fact of itself sufficient to disprove the hypothesis that the motive ability which presides over the circulation resides exclusively in the ventricles of the heart. The same animal electro-magnetic ability that causes the movement of the heart, when formed, also occasions the blood and other fluids to progress through the system, and by a modification of the electro-magnetic life energies of plants, their juices are likewise caused to permeate their structures.

(*l.*) After the principal vessels are formed, the development of new ones no longer appears to take place in dis-united points, but to be effected by the prolongation of loops from those already existing. This process has been witnessed in the finny tail and external gills of the common tadpole and water-newt, or eft.

(*m*). In reptiles, the lymphatics (absorbent vessels carrying lymph), are furnished with pulsating dilatations, or *lymphatic hearts*, which have for their office to propel the lymph into the venous system. In the frog there are two pairs of these, deep and superficial, one situated just beneath the skin (through which its pulsations are readily seen in the living animal). Their pulsations are totally independent of the action of the heart, and the respiratory movements, since they continue after the removal of the former, and for hours subsequent to the dismemberment of the animal. The pulsations usually take place at the rate of 60 in the minute, but they are not regular, nor are they synchronous on the two sides.

(*n.*) When a pupil in the anatomical schools, I recollect dissecting a very corpulent man about sixty years of age, most of whose arteries were ossified (converted into bone) which vessels broke when struck, as if made of brittle glass. In the year 1824 I presented to Mr. Grainger, who placed it in his museum, the heart of an old duck, that had become entirely a bony cavity, and yet the circulation of the blood was effected as if the heart had been capable of contracting upon its contents. These last two facts also prove that the circulation of the blood is independent of the contraction of the heart and arteries.

MOTIVITY AND DISSEMINATION OF VEGETABLE FLUIDS.

(424.) The sap of plants has mostly been regarded as a liquid absorbed from the soil by their fibrous rootlets, and has generally been supposed to be the chief source by which vegetables are nurtured; but a little reflection will, I think, teach us that roots only imbibe and carry simple water, sometimes containing, perhaps, certain *stimulating* soluble salts. This water, after threading the bodies and stems of plants, enters their foliage, and serves in its downward course as a vehicle for the *true* nourishing sap, which is *created* and *perfected* in the under surface of leaves. This sap, so generated, is, of course, varied in character, according to the frondage of each distinct vegetable, and becomes eliminated throughout the plant during its descent, thus promoting its development. It has likewise been presumed that vegetables reap much *nourishment* by the application to them of certain manures; but I conceive that this supposition, like the foregoing, is erroneous. Fertilising composts may *stimulate* by their presence, but can furnish no aliment that could directly enhance the enlargement of vegetable productions, by reason that manure may be spread over the land to any extent; but if we intercept light and *actin*, or withhold the application of a certain degree of heat, land-plants will not grow. Such being the case, we might as reasonably attribute the support and increase of size in plants to light, *actin*, and heat, as is assumed to take place from the application of particular manures, and assert that vegetables fed on these imponderable elements, from the fact that they cannot advance their economy without them. It is well known that large trees often grow out of the crevices of otherwise barren rocks, and that great archidacious and aerial plants flourish without touching any kind of soil. (See sec. 23.)

Again, many of the *deep* marine vegetables grow to an immense size without the aid of mould, air, light, and *actin*,

or the variations of heat, it is then evident that their production and nourishment must be independent of them or any ponderable or imponderable bodies known to us.

If the elements of the earth and air originated and afterwards sustained vegetable productions, all their characteristic secretions, or rather *creations*—when surrounded by similar circumstances—ought to be alike, but we find each separate species differing the one from the other, as regards their development and productions. On the contrary, when the chemist experiments to produce certain objects from like quantitive elements, the results of his labours are similar.

The vegetable world is proved at one hour to absorb, and then decompose, and at another period to give out pure carbonic acid, though some plants, both by day and by night are always exhaling this gas, as is the case with the fig tree.

By calculation it has been proved that a square mile of one of our common lime rocks (which were originally formed by the corollina and zoophyta, and upheaved from the bottom of our old world seas) if decomposed, would furnish more carbonic acid than is contained in the whole of our atmosphere, which consists, when pure, as a *law in Nature*, of the same quantity of nitrogen, oxygen and carbonic acid. This act has obtained ever since the earth has been surrounded by an aerial element. All the upper layers of our globe have been formed or produced by animal and vegetable matter. This fact points out that every living entity must *create* the carbon, &c., &c., that enters into its composition. (See sections 23, 24, 25, 26, 27, 28.)

From the foregoing postulates, I am led to presume that plants and animals materialize themselves and their secretions out of unparticled or undeveloped matter, or the ultra-gaseous matter of Professor Crooks, which entity obtains in all objective things, and extends throughout unimaginable space; or it may be, that all living existences can subsist and become unfolded by decomposing—by a process unknown to us—their present surrounding elements, into their ultimate unatomized principles, which ultimate imponderable elements are afterwards absorbed, and then assimilated according to the economy of each living entity. Animals have been known to subsist through great periods of time without partaking of any sustenance, and there are many cases on record where members of the human race have maintained a foodless existence for eight and twelve months, and even longer, without any

apparent diminution of their bodies. I would ask, how they supported their being? The answer must be—after the manner of plants, by imbibing sustenance from their surrounding mediums by means of the lungs and skin, &c. (See "Prolegomena," p. x. and sec. 34, 35.)

(*a.*) *Vegetable exhalation.*—All the tissues of plants are engaged in conveying water and sap—when formed—though some parts carry more than others, and the younger portions contain a greater quantity of fluid than the older. The water that passes up into the growing vegetation is disposed of by the process of exhalation, which is not mere evaporation of the aqueous fluid, but consists in a vital process, which appears to be analogous to our insensible perspiration. In this way the common sun-flower, three feet high, will lose one pound four ounces of water in a day. Hales contrived to measure the ability with which plants exhaled during the summer, and computed that in some vegetables it was five times as great as that which impels the blood in the large artery of the leg of a horse.

(*b.*) The motion of the fluids in plants is of two kinds, general and special. The general motions are those of ascent and descent, both of which may be rendered apparent by cutting through the trunk of a tree, when not only the divided surfaces below will present exudation of a liquid in its ascending course, but the surface above will exhibit a juice that is descending. External agents affect the circulation in plants, as light, heat, and especially electricity and magnetism, &c. The amount of aqueous fluid, which is so strong in the spring, ceases when the leaves are fully expanded. After the middle of summer, the sun's rays have less effect, the foliage is also obstructed by the deposition of secretions, the whole tree attains a state of plethora, and there is an increase of descending juices.

(*c.*) Numberless *theories* have been put forth to explain how fluids flow through plants, but they all *fail* to interpret the *cause.* I think there can be no doubt it is effected by electro-magnetic currents from the earth and atmosphere, which are —with certain vital essences—continually permeating all living entities. It has been shown that when water is escaping by *drops* from a vessel, if we electrify it, the same fluid will now run in a *rapid continuous stream.* Further, we must not forget that there is an intense *inborn* propensity appertaining to all materials to be in vivid motion, which proclivity is

greatly enhanced by electricity and magnetism. Dutrochet attributed the motion of vegetable fluids to the action of endosmose and exosmose (the passage of gases and fluids in and out through the pores of membranes). These processes are also found to be greatly enhanced by the employment of electricity.

(*d.*) The special motions of the juices of plants are of two kinds: the first is called rotation, the second cyclosis (having a spiral motion). The first, or rotatory motion, is best seen in the plant chara (found in ponds and ditches). In this weed there may be seen a number of green globules, varying in size, which proceed up on one side and turning round the top of the cell, pass down the other side, and again ascend. The rapidity with which these globules move, depends on the age of the plant. The motivity is increased by a range of temperature between 55° and 77° Fahr, and decreased by a greater amount or abstraction of heat. Secondly, cyclosis: this motion is found in all plants possessing spiral vessels.

(*e.*) Endosmose (gr. *endon* internal, *osmos* impulsion) is the attraction through an animal or vegetable membrane of thin by a denser fluid. Dutrochet found that if he filled the swimming bladder of a carp with thin mucilage, and placed it in water, the bladder gained weight by attracting the fluid through its sides; to this phenomenon he gave the name of *endosmose*. He also found that if he filled the same bladder with water, and placed it in thin mucilage, it lost weight, its contents being partially attracted through its sides into the surrounding mucilage, this counter phenomenon he named *exosmose* (*ex* out of, and *osmos*). The same circumstances were seen to occur in the transmission of fluids through the tissue of plants; it was found possible to gorge parts of vegetables with fluid by merely placing them in water, and to empty them again by rendering the fluid in which they were immersed more dense than that which they contained. It was also proved that this phenomenon took place with considerable energy. Dutrochet states that water thickened with sugar produces an ability of endosmose capable of sustaining a column of mercury of 127 inches, or the weight of 4½ atmospheres. He considered endosmose to be owing to intercapillary *electricity*, grounding his opinion upon the experiment of Porrett, who found that when two liquids of different levels are separated by a membrane, they may be brought to a level by establishing an electrical current between the two, thus

rendering the membrane more readily permeable, or rather increase molecular motion.

(*f*.) Electricity, heat, and movement are connected throughout Nature. The experiments of Dutrochet on the circulation in the vessels of the plant *chara*, illustrate this remark. At the freezing point, the circulation is slow, but if the water in which the vegetable is placed be gradually heated, it becomes accelerated, just in proportion as the temperature is increased up to 113° Fahr. Light appears to have little or no influence upon it.

(*g*.) The fluid from the earth ascends through the sap-wood and reaches the leaves, is there assimilated or made nutritive and inspissated, and then discharged back into the bark, settles downwards towards the root, and passes off laterally by the medullary passages into the heart-wood, which is sap-wood consolidated, by the addition of secreted matter, and may be always restored to the state of sap-wood by any solvent of the secreted matter, as the black deposit in ebony is dissolved by nitric acid. The ascending circular current in the cells of chara, is uniformly on that side of each cell which is most remote from the axis of growth, and consequently the descending current is on the side nearest the axis.

(*h*.) The movement of fluids in the individual cells of certain plants, as the chara, is quite distinct from the general circulation in the higher order of vegetation. It is a part of the process of formation, by which the nutritious fluid that is brought to each part, is converted into organised tissue.

(*i*.) Two sets of processes must be in constant operation, causing the ascent of fluids through the stems of plants, as shown by the following experiment: If the top of a young tree be cut off in the spring, and the divided extremity be immersed in water, it will absorb a sufficient quantity of fluid for the temporary supply of the leaves, whilst, on the other hand, the portion of the stem left in the ground will continue to pour out water drawn or forced up the roots. It is then evident that the propulsive ability of the roots, or rather the electro-magnetism of the earth causes the *ascent* of the fluid in the stem, since the latter will continue by simple imbibition, when the open extremities of the vessels are placed in a fluid, provided that the functions of the leaves are sufficiently active to occasion a demand for it. Moreover, there would seem no reason why the spongioles (the extremities of the ultimate fibrils of roots) should not be capable of absorbing fluid in the

winter as in summer, and if the ascent of the fluid from the earth depended entirely upon them, we should expect that it would be continued. That they are thus capable is shewn by grafting a shoot of an evergreen upon a stock whose leaves are deciduous (not evergreen, but falling), and it is found that the uninterrupted continuance of the demands meets with a corresponding supply. A still more striking experiment is to train a shoot of an out-door vine, or other plant, in a hot-house during the winter: the unusual stimulus will cause an immediate development of the buds, for which a supply of moisture is required, and this is derived from the roots, whose usual torpidity at this season is thus interrupted through want of action in the buds. Careful examination of the first movement of the humidity from the soil in spring also leads to the same result; for it is ascertained that the upward flow begins *near the buds*, where the electro-magnetism from the earth has its greatest action as it escapes from the extreme points of the growing vegetation, and may be progressively observed in the branches, trunk, and roots—the latter not commencing their action until the superincumbent column has been removed. It cannot be doubted, that the demand for fluid, occasioned by the vital processes which take place in the leaves, is the essential cause of the motion of the earth's moisture in the higher parts of the tree, and that the propulsive ability of the roots or rather the electro-magnetism of the earth is principally expended in raising it to the sphere of that influence. It is evident that the quantity of fluid absorbed by the roots will be proportioned to the rapidity of its removal by the leaves above, just as the continued rise of oil in the wick by simple capillary attraction, or rather thermo-electric action, is regulated by the combustion at its apex.

(*j*.) The nutritive juices of plants are made to *descend* through their structures by an electric action. Thus the resident electricity in the atmosphere is attracted by the extreme ends of vegetables, and as it descends through the stems it propels their fluids downwards into the ground. This conduction of electricity by plants is always taking place, and is made particularly evident to our senses, when there is a superabundant or abnormal quantity in the atmosphere by disrupting the taller trees. Every botanist and gardener becomes aware, that during the prevalence of electricity and warmth in the air, all plants rapidly shoot forth buds, and elongate their stems and tendrils, and also enlarge their leaves. Now as

action must always induce reaction, the *positive* electricity of the air when descending the growing plant, must call into operation the negative electro-magnetic element resident in the earth, which ascending and propelling upwards the water of the soil, gives rise to the rapid phenomenal growth in question, which is very perceptible in hot climates, where caloric as well as electricity is readily brought into play.

(*k*.) In regard to the circulation of the nutritious sap, which commences in the under surface of the leaves and descends from thence into the bark. The economy of this movement is not to convey this fluid in a direct line from one point to another—as is the case with the ascending aqueous current from the earth—but to supply every part with materials for its growth, or for the production of particular secretions. Hence the vessels, &c., in which it takes place, form a minutely-anastomosing network, instead of consisting of a system of straight and distinct tubes. Through this network the latex or elaborated sap is seen to move, exactly as does the blood through the capillary vessels of animals. This movement takes place, under favourable circumstances, with considerable rapidity; it is accelerated by heat and electrical influences and retarded by cold, and is subject to all those minor irregularities (such as the cessation of motion, or change in the direction of the current, in a particular channel) which are so constantly to be noticed by any one who attentively watches the capillary circulation in animals, and which clearly prove the operation of some influence independent of the heart's action.

The general direction of the nourishing sap through this capillary system is downwards. This circulation takes place most actively in parts which are undergoing a rapid development, and its energy corresponds with the vitality of the part. In the circulation of the elaborated sap, there is a constant attraction of its particles towards the walls of the vessels, and a continual series of changes produced in the fluid as the result of that attraction. The fluid, which has given up to a certain tissue some of its materials, no longer has the same adduction for that tissue, and it is consequently driven from it by the superior attraction then possessed by the tissue for another portion of the fluid, which is ready to undergo the same changes, to be in its turn rejected for a fresh supply. Thus in a growing part there is constantly renewed attraction for the nutritive fluid, which has not yet traversed it, whilst on the other hand, there is a diminished adduction for the fluid, which has yielded the

nutritive materials required by the particular tissues of the part, and thus the former is continually driving the latter before it. But the fluid, which is thus repelled from one part, may still be attracted towards another, because that portion of its contents, which the latter requires, may not yet have been removed from it. And in this manner, it would seem that the flow of sap is maintained through the whole capillary network, until it is altogether exhausted of its nutritive matter. The source of movement is thus entirely to be looked for in the changes that take place in the act of growth, and the influence of heat, electricity, cold, and other agents upon the movement, is exercised through their ability of accelerating or retarding these changes.

(*l.*) That positive and negative electro-magnetism is always passing into and escaping from the earth, is evidenced by taking a bar of iron, three or four feet long, and holding it in a vertical position. The iron becomes magnetic through a terrestrial influence. If the bar be inverted, the polarity will instantly be reversed: the extremity which is now lowest will be found to have a north pole, and the other extremity will become a south pole and *vice versa.* Bars of iron that have stood in a perpendicular position become magnetic, as found in our fire irons, and bars of windows. If we strike an iron rod, when upright, with a hammer, or rub it with a file—thus giving rise to an electric action—these manipulations render it polar or magnetic.

ENDURANCE OF THE IMPRESSIONS IMBIBED BY MATTER.

425. From the principle, long since established in mechanics and natural philosophy, that action and reaction are equal, it will follow that every impression which man makes by his words, or movements, upon the atmosphere, the water, or the solid earth, will produce a series of changes in each of these elements, which will never end. The words now going out of my mouth cause pulsations or waves in the air, and these—though imperceptible to man in his ordinary state—expand in every direction until they have passed around the globe, and produced a change throughout the entire atmosphere, nor will a single circumgyration complete the effect; but the sentence I now utter shall alter the world's aërial element through all future time. So that, as Professor Babbage remarks, "the air is a vast library, on whose pages are for ever written all that man has ever said or woman whispered." Not a word has ever escaped from mortal lips, whether for the defence of virtue or the perversion of truth; not a cry of agony has ever been uttered by the oppressed; not a mandate of cruelty by the despot; nor a false and flattering sentence by the deceiver; but it is registered upon the element we breathe. And could man clairvoyantly command his mind, he would discover that every particle of the air thus set in motion could be traced through all its changes, with as much precision as the astronomer can point out the path that the heavenly bodies have passed or will move through. No matter how many storms have raised the atmosphere into wild commotion, and whirled it into countless forms; no matter how many conflicting waves have mixed and crossed each other; the path of each pulsation is definite. To follow it requires, indeed, an ability of analysis superior to human, but not inferior to spiritual beings and their divine controller. The same phenomena are true of the waters. No wave has ever been raised on their exterior, no keel has ever ploughed their surface, which has not sent an

influence and a change into all oceans, and modified every wave that has rolled in upon the farthest shores. As the vessel crosses the deep, the parted billows close in, and every trace of disturbance soon disappears from human vision. Nevertheless, it is certain that every track thus furrowed in the waters has sent an influence through their entire mass, such as is calculable by distinct formulæ, and it may be that glorified minds, by the principles of celestial mathematics, can as easily trace out the paths of the unnumbered ships that have crossed the seas, as the astronomer can the tracks of the celestial orbs. The solid earth, too, is alike tenacious of all the impressions we make upon it, not a footprint of man or beast is marked upon its surface that does not permanently change the whole globe. Every one of its countless atoms will retain and exhibit an infinitesimal, but real, effect through all coming time. It is too minute, indeed, for the cognizance of the senses of man in his common state. But in a higher sphere, there may be inlets of perception acute enough to trace it through all its bearings, and thus render every atom of the globe a living witness to the actions of every existing being. In view of these facts, I again cannot regard the glowing language of Babbage as an exaggeration when he says, "The soul of the negro, whose fettered body, surviving the living charnel-house of his infected prison, was thrown into the sea to lighten the ship, that his *Christian* master might escape the limited justice at length assigned by civilized man, to crimes whose profit had long gilded their atrocity, will need in the hereafter—touching human accounts—no living witness of his earthly agony, when man and all his race shall have disappeared from the face of our planet. Ask every particle of air still floating over the unpeopled earth, and it will record the cruel mandate of the tyrant. Interrogate every wave which breaks unimpeded on ten thousand desolate shores, and it will give evidence of the last gurgle of the waters which closed over the head of his dying victim. Confront the murderer with every corporeal atom of his immolated slave, and in its still quivering movements he will read the denunciation," thou art the man."

People in general are amazed when we speak of the materiality of light, heat, and electricity. What then will be the amount of their wonder, when I state that our thoughts and feelings—and the effects they produce—become as it were spiritually materialized, and that their semblances are im-

pressed or imaged upon every atom of the universe. For instance, I have known some of my sensitive clairvoyants relate the past history of things and beings, and prophesy as to their *future* experiences, and even describe the fancies formed in the minds of certain persons, and the sensations that pervaded their systems in the long past periods of their lives. These facts show that soul-born representations must exist for ever, and will have a pictured being, when Time's ancient Temples, fashioned by the hands of man, and even the rocks whereon they stood, fabricated or created by living corollina and zoophyta, shall have crumbled into dust, no more to be recognised by the eyes of the then living creatures. Further, I have known several persons—two ladies and a physician—who related to me that during submersion in the water, and just previously to becoming insensible, every feeling and act of their lives, passed in review before them, just as if they had been the events of the previous hour. Two of these individuals—the doctor and one of the gentlewomen —stated, that so beautiful and *attractive* were, at one moment, some of their visions, as regards a future state, that they greatly regretted awakening again up into this world's associations, with its empty pleasures and unsatisfactory cloying pursuits.

(I.) Most individuals, are aware, that diseases, deformities, and propensities, are hereditary, showing that impressions and changes propagated in or among animals and vegetables in one age, will crop out in future generations. Thus the descendants of deaf and colour-blind people will inherit—through a long issue of offspring—deficiences in regard to sound and colours, &c.

(II.) The various breeds of domestic cattle, of the horse, dog, &c., offer abundant evidence of the modifying influence of external conditions, since they originated from single stocks, and their peculiarities have been engrafted—so to speak—on their successors.

(III.) Between the Shetland pony and the Arabian racer, the Newfoundland dog and Italian greyhound are greater differences than betwixt the lion and tiger. These domesticated races, however different their external characters, have a common origin, as proved by the fact, whenever they return to a state of nature, (as seen with the dogs introduced by the Spaniards into Cuba, and the horses and wild cattle, which now overspread the plains of South America,) the differences of

breed disappear, and a common form is possessed by all the individuals. Even what has been vaguely called *instinct*, which must have remained dormant for so many generations during the domesticated condition of the race re-appears when this change takes place in their habits. Thus among the wild horses there is the same tendency to appoint a sentinel and associate in herds under the protection of a leader, as among those of Asia, whose ancestors are not known to have ever been rendered into subjection. The wild dog—like the jackals and wolves—from which no doubt they originally sprang—hunt in packs and all become of one marking, colour, and character, varying of course according to the climate and their surroundings.

(IV.) *Relative to the vegetable world.*—Who could detect in the common cabbage, with its short fleshy stem and large succulent leaves—gathered into a heart several feet in circumference—the wild kale (*brasica oleracea*) or natural cabbage, with its tough slender stem and small glaucous (blue) leaf which trails among the shingle of the seashore and upon the different cliffs of Europe? Yet this maritime weed is the original parent of the garden cabbage, including the savoy, cauliflower, and brocolis. Again, who at first could suppose that the sloe—the fruit of the common blackthorn—was the antecedent of our delicious purple and yellow plums, or imagine that the sour crab of the wilderness, was the source of the numberless varieties of apples now cultivated by horticulturists.

Further, who would conjecture that all the different roses that beautify our parterres, originated from the sweet-briar and other wild shrubs that are found in the cooler waste parts of the globe we inhabit.

(V.) *As regards giants and dwarfs.*—The perfection—as to the height of the human race—marking *health* and beauty, is 5 feet 10 inches for the man, and 5 feet 5 inches, relative to the woman. The general stature of mankind of course varies in different countries, and most probably originated through certain impressions chiefly proceeding from their progenitors and modified by external agents. In measuring the Pantagonians they were stated by the Spaniards in 1785 to be from 6 feet 8 inches to 7 feet 2 inches in height. At a later period Captain Wallis affirmed, that after careful measurement he found them to be from 5 feet 10 inches to 6 feet. Individuals are sometimes met with who greatly exceed the ordinary height. Thus, one of the King of Prussia's gigantic guards—a Swede—measured 8 feet 6 inches. The skeleton of Charles Byrn, who

went by the name of O'Brian (the cognomen of an Irish race of giants), is now in the College of Surgeons, London, he died at the age of 22, and measured, when living, 8 feet 4 inches. I myself recollect a Mrs. Gunter whose arm, when stretched horizontally outwards, I could walk under without touching it, my stature being 5 feet 10 inches.

Relative to dwarfs.—Buffon states that Bebe, the pigmy, belonging to Stanislaus, King of Poland, was but 23 inches high, he was well proportioned and died at 23. Madlle. Crachami, the Sicilian dwarf, who died at ten years of age, was only 20 inches in height, her skeleton is also in the College of Surgeons. "General Tom Thumb" (whose real name was Thomas Haneman), was 24 inches in height, had light hair, pretty childish face, and when 17 years old he only weighed 15lbs.—the size of a large leg of mutton. He was very intelligent, tractable, active, and amusing, well proportioned, and an inveterate gambler at cards. Barnum is said to have made £100,000 by the exhibition of his person. It has frequently been noticed that both giants and very short people often have offspring of similar stature to themselves, so that a race of men might thus arise of extraordinary smallness or leviathan size. The King of Prussia had a corps of gigantic guards, consisting of the tallest men that could be drawn together from all quarters. A regiment of these huge men was stationed, during 50 years, at Potsdam. A great number of the present inhabitants of this place are of very high stature, which is more especially striking in the numerous overgrown figures of women. This is certainly owing to the connexions and intermarriages of these tall men with the females of the town.

VI. *Hæmorrhage, or bleeding.*—In some persons there is a peculiar disposition to bleeding by reason of their hæmorrhagic diathesis (constitution). Abernethy used to speak of hereditary bleeding families, in all of whom he stated that it was extremely difficult to stanch the blood from even the slightest wound. Among these there are many cases where blood is poured forth into the interior of the body, without any rupture of a vessel. This is called hæmorrhage by exhalation. Blood in such individuals has been seen flowing even from the skin of the face, hands, and feet, &c. In these cases the surface is covered by a dew, as it were, of blood; if this exudation be wiped away, no unnatural appearance is perceptible, but the blood flows again. Spontaneous bleedings also occur in some of these families at regular periods, from the gums, breasts,

axillæ (arm-pits), or kidneys, but most frequently from the stomach and lungs.

(VII.) *Hybrid* (gr. *Ibris*, a mule), *a mongrel plant, or animal.*—The characters of the male parent of the mother's first progeny show themselves in her subsequent offspring by other males, however different these males may be in form or colour. Thus a young mare, after producing a female hybrid by the quagga, had first a filly, and afterwards a male colt, by a fine black Arabian stallion. These both resembled the quagga in the dark line along the back, the stripes traversing the forehead, and the bars across the legs; in the filly, the mane was short and stiff, like that of the quagga: in the male colt, it was long, but so stiff as to arch upwards, and hang clear of the sides of the neck—in other respects they were nearly pure Arabian. This economy ensues among many animals of a like genus, especially as regards the bird tribe.

(VIII.) *Permanency of odorous impressions.*—Musk is the strongest and most enduring of perfumes, and so subtile that everything placed near it becomes infected, and for a long time retains the scent; vessels of silver even, a metal which, as much as, if not more than others, readily becomes purified from odorous substances, do not part with the fragrance of musk, which may have been placed in them, for a very long time. Its effects on the nervous system, &c., *when fresh*, are often very violent, causing blood to start from the nose, eyes, and ears of those who inhale it, when recently procured from the musk-deer.

(IX.) *Endurance of impressions made on the nervous system.*—Persons who have lost their limbs often entertain the idea that they still possess them, till by their sight, or some other means, they correct the erroneous impressions of their sense of touch. For example, the constant cry of a patient who has just lost the lower extremity, while the stump of the thigh is being dressed is, that the attendants are squeezing his knee, cutting his foot, or injuring some other part of the limb, which he cannot believe has been removed. The reason of this is, that when the filaments of the nerves in the stump, which are destined for the knee, &c., are touched, the knee seems to be impressed; when those which are going to the foot are excited, this member appears to suffer. So deceptive are these sensations, that even years after the loss of the limb, or for the rest of their lives, persons occasionally endeavour to perform some act with the stump which they were accustomed to do with

the part they have lost. After the removal of a limb, people sometimes feel the original pains from which they suffered, and more frequently itching sensations, &c., causing them at periods to put down their hands to scratch or rub the parts in question.* It should be remembered that all the impressions ever made on the body are conveyed to and stamped upon the brain, and through it on the mind. And it must not be forgotten, that though the *natural* material limb is severed from the body, the *spiritual* member still remains attached to the inner-man.

(X.) *The impressions made on certain distinct parts of animals may be aroused into action by external agents.*—The *severed* head of a turtle will snap its jaws, if irritated, hours after it is cut off. Redi deprived a large tortoise of its head, without which it continued to live for 23 days, but when its fore and hind legs were pricked or poked it drew them up with great energy, and executed many other movements. He also decapitated four other tortoises, and on opening two of them 12 days afterwards he saw the heart beating and the blood enter and leave it.

(XI.) Persons who have recovered after the bite of a rattlesnake, never fail to have *annual* pains at the time they were bitten. ("Penny Cyclopædia," vol. 26, p. 352.)

(XII.) In many of the lower crustacea (as the water-fleas, &c.), a single act of fecundation serves to fertilise all the eggs which the female produces during her whole life, and even her female progeny up to the sixth generation have been found to be also impregnated, so as to be capable of propagating without the male, as in the aphides (plant lice).

(XIII.) In the year 1791 one of the ewes on the farm of Seth Wright, in the State of Massachusets, produced a male lamb which, from the singular length of its body and shortness of its legs, received the name of the *otter* breed. This physical conformation, incapacitating the animal from leaping fences, appeared to the farmers around so desirable that they wished it continued. Wright determined to breed from this ram. In a few years he obtained a great number, and, when they became capable of breeding with one another, a new strongly marked variety, before unknown to the world, was established.

* The above reasons given for the cause of the sensations in the knee and foot after amputation, is very erroneous, since there are no filaments in the stump that supplies the lower part of the limb, but only the divided large main nerve, which merely serves as a conductor of the impressions made on the nervous threads that were below it.

(XIV.) *Impressional propensities derivative or hereditary.*—In the mongrel race of dogs employed by the inhabitants on the banks of the Magdalena, which are used almost exclusively in chasing the Mexican musk-boars or the white-lipped pecari, a peculiar instinct has become hereditary. The address of these hounds whilst hunting consists in restraining their ardour, and attaching themselves to no pecary in particular, but keeping the whole herd in check. Now among these dogs, some are found which, the very first time they are taken to the woods, act as if well acquainted with this mode of attack; whereas a dog of another breed starts forwards at once, and is, of course, surrounded by these Mexican musk-boars, and whatever may be his strength, is instantly destroyed. A similar natural impulse belongs to the progeny of the pointers and setters of this country, which are often known to back the game, when taken to the field for the first time.

(XV.) It was found that our greyhounds, when on the mountains of Mexico—9,000 feet in height—could not support the fatigue of the chase in this attenuated atmosphere; and before they could come up with their prey, they lay down gasping for breath; but the same animals have produced whelps, which have grown up, and are not in the least degree incommoded by the want of density in the air, but run down the hares with as much ease as the fleetest of their race in Europe.

(XVI.) Transplanted races of men, after long residence in a country, begin to present some of the characters of the aborigines, *especially their descendants*. The negro families, which have long dwelt with whites as domestics, gradually acquire an European-like physiognomy, so that a *Dutch* negro may easily be distinguished from others.

(XVII.) Shepherd's dogs display an extraordinary hereditary sagacity respecting their vocation. The descendants of dogs, to which peculiar tricks have been taught, exhibit an unusual aptitude for learning the same practices.

(XVIII.) Dogs that have been deprived of their tails by accident or design, have produced puppies with a similar deficiency; cats also, that have lost the same member, often produce one or two tailless kittens at each litter; cats, likewise, with even distorted caudal appendages, have been known to transmit their deformity to some of their offspring. (See Article " Mothers' Marks.")

(XIX.) A young duck, as soon as it has escaped from its

shell, swims in the pond, and will also catch gnats and flies, but give it a wasp, and it immediately, like its mother, avoids an insect, the sting of which would probably kill it. Young chickens, likewise, as soon as they are hatched, will take shelter under the parent's wings at the presence of a hawk, while they show no dread at the approach of a turkey or goose, however near they may come to them.

(XX.) *Revival of long past impressions in the human race.*—Abercrombie relates the circumstance of a young girl, whose employment was keeping cattle, and who slept for some time—much to her own annoyance—in the room adjoining one occupied by an itinerant musician. The man, who played exceedingly well, being an enthusiast in his art, frequently practised the greater part of the night, performing on his violin different compositions, whilst the girl complained bitterly of being kept awake by the noise as she called it. Some time after this, she fell ill and was removed to the house of a benevolent lady, who undertook the charge of her. After a time the family were amazed by frequently hearing most exquisite music in the night, which they at length discovered to proceed from the girl. The sounds were those of a violin, and the tuning and other preliminary processes were accurately *imitated*. She went through long and elaborate pieces, and afterwards was heard imitating, in the same way, the sounds of an old pianoforte that was in the house. (See Article "Sound.")

Dr. Steinbech mentions the case of a clergyman, who being summoned to a dying peasant, found him praying aloud in Greek and Hebrew, a mystery explained by the circumstance of his having, when a child, frequently heard the minister of the parish praying in these languages. He had, however, never understood the orisons, or indeed paid any attention to them still less had he been aware that they lived in his memory.

When a student at the Hospital, I recollect an elderly woman who, during her illness, became delirious, and whilst in this state she kept talking to herself in some guttural language, which the persons present did not understand. It so happened that a nurse from a distant ward came to the bedside of the patient, and after listening to her for a time discovered that the invalid was speaking the Welsh dialect. When the patient recovered from her illness this said nurse one day addressed the woman, that had been delirious, in her own language, but the patient only stared at the interlocutor without comprehension. It afterwards turned out that the sick person in question

left Wales when a little girl, and had subsequently forgotten every vestige of her native language.

Another extraordinary instance is related of a lady born in India, and brought up till she was six years old by a Hindoo nurse. This lady, during an attack of fever—when 27 years of age—forgot the English language entirely, and for some time could speak nothing but Hindostani, of which she had previously lost the memory of even the very sound.

(XXI.) *Events are impressed or iconographed (imaged) on all our surroundings.*—Abercrombie mentions the case of a lady, who in the last stage of a disease, was taken from London to the country; to this place of residence her little daughter was carried, who after a short interview, was borne back to town. A few days after this event the lady died. The child in question grew up to a mature age without any recollection of her mother. At this period of life she happened to be taken into the room in which her parent expired, without knowing it to have been so; she started on entering the chamber, and, when a friend who was with her, asked the cause of her extreme agitation she replied, "I have a distinct impression of having been in this room before, and that a lady, who lay in that corner, and seemed very ill, leaned over me and wept." A clairvoyant would have seen and described this chamber-event with all its bearings, because every passing incident that can transpire is imaged on its surroundings, which fact is evidenced when occurrences take place before sensitive surfaces, as witnessed in the process of daguerreotyping. Now the above circumstances, as well as being pictured on the walls, &c., were also at the same moment impressed—when she was a child—on the lady's brain or rather upon her inner self-hood, and on her coming into the room in question—when a woman—the original representations were aroused into action by a double influence, first by the operation of the pictured scene resident in the bedchamber, and secondly by her maternal sympathies—hence the acuteness of her feelings.

(XXII.) A boy, four years of age, received a fracture of the skull, for which he was trepanned. At the time of the operation, being in a state of perfect stupor, of course he was unconscious of the surgical appliance. After his recovery he retained no recollection, either of the accident or the trepanning. At the age of 15, during the delirium of a fever, he gave his mother an account of the operation and the persons who were present at it, with a correct description of their dress and other

minute particulars. He had never been observed to allude to it before, and no means were known by which he could have acquired the circumstances which he mentioned.

(XXIII.) *Descent of impressions in regard to mankind.*—Dr. Prichard cites examples where the peculiarities of the parents have been transmitted to the offspring, as where children, entirely white or perfectly black, have sprung from the union of the European and the negro. Sometimes colour or other anomalies of one parent, after having failed to show themselves in the immediate progeny, reappear in a subsequent generation, as where a fair child is born of two black parents, the grandfather having been a white.

(XXIV.) Mr. Carlile quotes cases where the members of certain families had supernumerary fingers and toes through three or four generations. (Phil. Trans. v. I. p. 486.)

(XXV.) There is a family in North America, some individuals of which have been affected with blindness for the last hundred years. Family character, like a family face, will often be lost in one generation, and appear again in another. Beauty of form and feature are derivative as seen in the Georgians and Circassians.

(XXVI.) *Hereditary habits.*—Saturday night's children, or those begotten when the parent was inebriated, often prove to be drunkards and defective in intellect: wherefore Diogenes said to a stripling—somewhat crack-brained and half-witted, "Surely, young man, thy father begot thee when he was intoxicated." (Plutarch's "Morals.")

Esquirol relates that the children, whose existence dated from the horrors of the first French Revolution, turned out to be weak, nervous, and irritable in mind, extremely susceptible of impressions, and liable to be thrown by any extraordinary excitement into a state of insanity.

Shakspere seems to recognise the law of the transmission of temporary mental qualities. Thus in Coriolanus we find the following passage.

> "Come on, ye cowards, ye were got in fear,
> Though ye were born in Rome."

(XXVII.) Children often possess the make and fashion of the body peculiar to one or other of their parents. Haslam quotes examples, where the son had the gait, voice, and handwriting of his father, though the male parent died before his son had been taught the use of the pen, and probably never saw the handwriting of his father.

(XXVIII.) *Impressions made by the contact and even presence of things.*—Baron Reichenbach, through innumerable experiments, proved that by touching different bodies with a magnet or the apex of a crystal, his patients became influenced by the presence of substances so treated, and especially on coming in contact with them. I have many times witnessed my clairvoyants to be capable of the same susceptibilities, and also known them proclaim the portions of the things that certain persons had touched, and they likewise became influenced by the characters of those individuals who had been near, and especially if they placed their fingers on the substances in question. Moreover they could even record the observations the different parties had made whilst manipulating these said objects. Further, I have at periods solicited different people to breathe over certain surfaces, as a sheet of paper or other fabric, and when these substances were afterwards presented to my clairvoyants, they have immediately discovered and described the features of the person whose breath had passed over these materials. I have also known them even name the parties—if known to them—whose face was thus pictured on the articles so treated. Again, some lucid individuals were found capable of giving the history of the things that particular objects had come in contact with or even been near. I might here mention that whilst I was mesmerising water my clairvoyants could see the animal magnetic fluid of my body escape from the ends of my fingers into the glass, they could likewise perceive that the streams from my digits sank to the bottom of the water, and after a time they would exclaim, that the fluid bursting from my hand was running over the edges of the vessel on to the table. This fact would point out that the animal magnetic principle obeyed the so-called laws of gravity. Further, I with many of my visitors have at different periods known Major Buckley, Dr. Ashburner, and others, write with their fingers on the ground or elsewhere, a certain name or sentence, which at a future time my patients could read as if written with ink on a white surface. Nay, I have witnessed the above gentlemen effect this feat by the mere effort of their will, and again, lucid individuals could, at a subsequent period, *decipher* these mind-written characters. (See my work on "Will-Ability.")

(XXIX.) When a new nose is made, by partly detaching and bringing down a piece of skin from the forehead, the patient at first feels, when anything touches the tip of his

recent nasal organ, as if the contact were really made with the upper part of his forehead. This fact is a very evident proof that former impressions can be made evident to the senses.

(XXX.) Dr. Perceval mentions the case of a snuff-taking countess, in whom, when seized with apoplexy, irritation of the nose with a feather produced contraction of the forefinger and thumb of the right hand. Mr. Travers has recorded a similar fact in the case of a boy, who, when apparently insensible from depressed fracture of the skull, assisted in removing his clothes, preparatorily to the required operation.

(XXXI.) *There are an infinite variety of personal character.*—Impressed on every individual, more or less, are the peculiar characteristics of his immediate progenitors. Thus each man has certain apparently fixed predispositions which incline him to the identical pursuits and habits of thought that give him all the strongly-marked characteristics for which his parents were distinguished.

Circumstances of birth, society, and culture are engaged in forming, deforming, or reforming the man; yet, remaining through all these, can be seen the direction and peculiarity of hereditary character. And to whatever direction this may tend, that way will each ability and faculty incline, and thus go on to some extreme point, where a complete phenomenon will be presented. In some instances we find the barren idiot, in others, the fertile philosopher. Hence we have had, and still have, men celebrated for stupendous talents in certain departments, such as mechanics, poetry, astronomy, and general philosophy. When we read of men having any of these abilities remarkably developed, or witness them in their moments of manifestation, we are impressed to refer them to supernatural agencies. But often if we search deeply they declare themselves as out-births and legitimate consequences of some distinct or proximate causes. In fact, man is a combination of impressible materials. He is so tenderly constructed that everything which he comes near or in contact with, stamps its likeness upon him. So likewise is the mind influenced by prevailing convictions, and even opinions. The most susceptible minds are the first to be impressed; but every class or structure of mental organisation is to some degree influenced by those doctrines which receive the general consent of the community. Man does not yet know that he is moulded into any shape; or, more properly, that he is *magnetised* into various states of thought and feel-

ing, by the positive influence of things, circumstances, and opinions, which preponderate in society. Man is not aware that he is almost as much under the control of education, situation, pride, reputation, as the soft clay is under the sway of the potter's hand. Notwithstanding his ignorance of these things, they are absolutely true.

(XXXII.) James the First of England had always a horror of a drawn sword. This feeling resulted from his mother, Queen Mary, having seen when pregnant the *royal assassins*, headed by her husband, rush with naked blades into the cabinet where she was supping in company with her accomplished musician, Rizzio, and kill him before her eyes.

(XXXIII.) If chloride of barium is put upon a plate in a darkened room, and the hand be placed beneath it, so soon as the warmth of the hand has penetrated the utensil, the form of this member is seen delineated on the upper surface of the plate.

(XXXIV.) People having been sent into the mesmeric sleep at a certain hour, have, subsequently, often become somnolent at the same period of the day for weeks afterwards without being again magnetised. My friend, Major Buckley, once sent a gentleman's dog into the mesmeric sleep on the hearth-rug, and the animal continued to fall into a state of sound repose at the same period of the day for a long time. The master of the animal was accustomed to laugh at animal magnetism, and yet he accused the Major of having spoilt his canine companion.

(XXXV.) The Rev. Mr. Townshend states that one of his mesmeric patients could, when five or six pocket-handkerchiefs of the persons present were mixed together, quickly and correctly restore each to the owner.

(XXXVI.) Many mesmerisers and rubbers acquire the pains situated in the manipulated parts of their patients, and would often communicate them to other persons whom they afterwards placed their hands near or upon, like certain contagious maladies.

XXXVII.) Dr. Gregory relates that he could breathe a dream into a glove and send it to a lady, who on the night of the day, after putting it on, would have in her sleep the vision he had impressed upon this article of her dress.

(XXXVIII.) Mr. Barth mentions that his patients, when in the sleep-waking state (and some few in their normal condition, if in darkness), could see the animal magnetic element

upon objects that had been mesmerised. They described it as like spangles, or a luminous mist. Many persons, he continues, can perceive a difference of taste in mesmerised water when compared with that fluid which has not been magnetically manipulated. Mr. B. further relates that he knew a susceptible gentleman, who when on a visit, requested a young lady at the house to mesmerise him some water, showing her how to do it. On sipping the liquid in question, he found that it had a very strong flavour of brimstone, so much so, that he could scarcely drink it. On naming it, he discovered that the lady at this time had been taking brimstone and treacle. Some persons who readily discern the taste of things, declare magnetised water to be rather disagreeable, saying it had a metallic taste, or was like ink and other resemblances. Sleep-walkers relish this water much, if mesmerised by their own manipulator, or by some person they like, whose influence is agreeable to them. If their own magnetiser has made passes over it, they at once perceive the fact. Indeed they can distinguish if the impression, which they may see on any mesmerised object, is that appertaining to their own magnetiser, or belonging to some other person. Dr. Storer, of Bristol, once called on Mr. Barth and solicited to see one of his patients. The Doctor, when in the consulting room, purposely made a few passes over the seat of a certain chair, after which process Mr. B. sent for a Miss Fletcher, one of his sleep-walkers, who was requested to place herself in the seat so manipulated, which she did. Dr. S. and Mr. B. then recommenced their conversation, taking no notice of the patient in question, who soon passed into the somnambulistic state. On inquiring why she was asleep, the lady laughed, and replied that "the gentleman visitor had mesmerised the seat." "How do you know that?" inquired Mr. B. "I see and feel the influence on my chair, and it is not like yours," was the reply. Mr. Barth, in continuation, relates that after manipulating certain persons, he sometimes became very indisposed, and to get rid of the influence, he has at times mesmerised his dog or cat, and thus relieved his oppression; but he always noticed after operating on these animals that they became indisposed, and would not eat, though he tempted them with meat and milk. "If," observes Mr. B., "I solicited the dog, gun in hand, to go out, he followed readily for a little way, and then dropped his head and tail, and afterwards crawled home."

(XXXIX.) *Spectral illusions are sometimes the result of*

former mind impressions.—Dr. Werner states that Professor Happach had an elderly maid-servant, who was in the habit of coming every morning to call him, and on entering the room, which he generally heard her do, she usually looked at a clock that stood under the mirror. One morning she entered, as he supposed, his bedchamber, but so softly that though he thought he saw her, he did not *hear her footfall*, she appeared to go, as was her custom, to the clock, but on coming to his bedside, she suddenly turned round and left the room. He called after her, but as she did not answer, he jumped out of bed and pursued her, but could not see her, however, till reaching her room, where he found his servant fast asleep in bed. Subsequently the same thing at times occurred again.

(XL.) It is reported of Captain C. that he on a particular occasion went to see his confessor, who he found was very ill, which circumstance preyed upon his mind all the day, until the hour of retiring to bed, when, to his great astonishment, he saw in the room the figure of the priest. He proceeded to address him, but received no answer. At last the captain advanced on the phantom, which seemed to sink into an elbow chair. To ascertain positively the nature of the figure, the soldier sat down in the same seat, thus ascertaining that it was an illusion. The confessor afterwards recovered, so as Dr. Johnson says "nothing came of it." The Germans and Austrians, with many other nations, both in olden and modern times, speak of the double of a person, or the dappelganger of the Swedes, or the second self, which was often seen by several persons at the *same time*. The evidence of this phenomenon is "too loud," as the Greeks express it, not to have a foundation. "There are more things in heaven and on earth than we dream of in our philosophy."

(XLI.) There have lived, and still exist, individuals—especially among the Africans—who can follow, for immense distances, the footsteps of certain characters, particularly murderers. This capability of recognising the impressions left on matter, chiefly appertains to animals, as familiarly witnessed in the domestic dog.

(XLII.) *The capabilities of our forefathers crop out through many generations.*—Thus, the descendants of the North-American Indians and natives of New Holland, like the creatures of the wilds, never lose their way—not even their young offspring—when treading the pathless forest or barren waste. Again, the intellectual faculties of persons, developed by *cultivation*, are often transmitted to their descendants.

(XLIII.) The issue of foxes, bred in a hunting country, are more cunning than those reared where this very *cruel* pastime is not practised.

(XLIV.) People who have chased the land crab relate, that when it clasps the hand of the pursuer, it shakes off its claw, which member *continues* to squeeze the would-be captor with incredible energy for some time after the separation of the limb from the body.

(XLV.) The results of vaccination have very greatly modified the effects of small-pox, and the external character of the human race.

(XLVI.) All things, says Emerson, are engaged in writing Nature's history.

MOTHER'S MARKS.

(426.) *Impressions made on pregnant animals conveyed to their offspring.*—Marks communicated through emotional impressions by mothers to their progeny, during pregnancy, are by no means rare. Among these, as regards the human race, we sometimes find images of certain things, colours of animals, fruit, and other substances, stamped, as it were, on the child, also prints of the hand on the very parts where the pregnant woman has been suddenly touched. Even deprivation of particular members of the body and other malformations ensue, from the sight of these personal deficiencies, and sometimes representations of diseased parts are depicted. These facts testify to the truth of the capability of the mother to form, or rather produce effects upon her offspring whilst in the womb. The Romans and Greeks were well aware of the influence of external agencies on the minds of matrons as regards their progeny, hence they justly believed that if they surrounded ladies, when pregnant, with *happy* circumstances, beautiful beings and objects, they should promote symmetry of *form* and comeliness of *features*.

"Could a woman"—suggests Lavater—"keep an accurate register of what happened, in emotional moments, during her state of pregnancy, she might probably be able to foretell the chief incidents, philosophical, moral, intellectual, and physiognomical (face features) which should appertain or happen to her child. Imagination, actuated by desire, love, or hatred, may with more than lightning-swiftness, kill or enliven, diminish, enlarge, or impregnate the organised child in the womb, with the germ of amplifying or lessening wisdom or folly, death or life, which shall first be unfolded at a certain time, and under particular circumstances. The hitherto unexplained, but sometimes decisive and revealed, creative and changing ability of the soul, may be in its essence identically the same with what is called a faith-working miracle, which latter may be developed and increased by external causes

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NEW VIEWS

OF

MATTER, LIFE, MOTION,

AND

RESISTANCE:

ALSO

AN ENQUIRY INTO THE MATERIALITY

OF

ELECTRICITY, HEAT, LIGHT, COLOURS, AND SOUND.

To be Published Monthly.

BY

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Author of "Will-Ability," "Beauty and the Laws Governing its Development," "Homœopathy contrasted with Allopathy," "A Dissertation on Diets and Digestion," &c., &c.

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wherever they exist, but cannot be communicated where they are not."

(*a*.) A pregnant woman was engaged at a card party, and only wanted the ace of spades to win all that was staked, and, as it happened, in the change of cards, the so-much-wished-for ace was given her. The joy of this success had such an effect upon her imagination that the child, when born, had the ace of spades depicted in the pupil of the eye, and without injury to the organ of sight. (Lavater.)

(*b*.) A lady in Rheinthal had, during her pregnancy, a desire to see the execution of a man who was sentenced to have his right hand cut off before he was beheaded. She saw this member severed from the body, and instantly turned away and went home without waiting to see the death that was to follow. This lady bore a daughter, who is still living; she had only one hand. The right hand came away with the after-birth. (Lavater.)

(*c*.) A girl who was taken about as a show, was spotted with hair like a deer, and particularly remarkable for the spongy excrescences on her back, which were also thinly overgrown with deer-coloured hair. Her mother, during pregnancy, had quarrelled with a neighbour concerning a stag, which was flayed in her presence. The colour and growth of this child's hair was also like that of the stag. (Lavater.)

(*d*.) "There was once," says Voltaire, "introduced, in my presence, into the court of a pregnant woman, a showman, who exhibited a little dancing dog with a kind of red bonnet on its head. The woman called out to have the figure removed; she declared that her child would be marked like it; she even wept, and nothing could restrain her confidence and peace. 'This is the second time,' she said, 'that such a misfortune has befallen me. My first child bears the impression of a similar terror that I was exposed to; I feel extremely weak; I know that some misfortune will reach me.' The woman was but too correct in her prediction. She was delivered of a child similar to the figure which had so terrified her. The bonnet was particularly distinguishable. The little creature lived two days." "In the time of Malebranche," continues Voltaire, "no one entertained the slightest doubt of the adventure which he relates, of a woman who, after seeing a criminal racked, was delivered of a son whose limbs were broken in the same places in which the malefactor had received the blows of the executioner. All the physicians at

the time were agreed that the imagination had produced the fatal effect upon her offspring."

It has been asked, in what way do you suppose the affections of a mother should operate to derange the members of the child in the womb? "Of that I know nothing," exclaims Voltaire, "but I have witnessed the fact. You new-fangled philosophers enquire and study how an infant is *formed*, and yet require me to know how it becomes *deformed*." (Voltaire, v. 2, p. 63.)

(*e*.) An infant recently born in Cardiff has distinctly marked upon his forehead a balloon and car in which persons ascend. The mother witnessed a balloon ascent in London some months ago, and was apprehensive of the aërial voyager's safety. (Local Paper).

(*f*.) We have demonstrative evidence that a fit of passion in a nurse vitiates the quality of the milk, so as to cause colic and indigestion, or even death of the suckling infant. If in the child already born, and so far independent of its parent, the relation between the two is thus strong, is it unreasonable to suppose that it should be yet more predominant when the child lies in the mother's womb, is nourished indirectly by its parent's blood, and is, to all intents and purposes, a part of her own body? If a sudden and energetic emotion of her own mind exerts such an influence upon her stomach as to excite immediate vomiting, and upon her heart as almost to arrest its motion and induce fainting, can we believe that it will have no effect on her womb and the fragile being contained within it? Facts and reason, then, alike demonstrate the reality of the influence, and much practical advantage would result to both parent and child were the conditions and extent of its operations better understood. Among facts of this class, there is none more striking than that of Baron Percy, who relates that after the seige of Landau, in 1793, that in addition to the violent cannonading, which kept the women in a constant state of alarm, the arsenal blew up with a terrific explosion, which few could hear with unshaken nerves. Out of ninety-two children born in that district within a few months afterwards, the Baron states, that sixteen died at the instant after birth, thirty-three languished from eight to ten months, and then died, eight became idiotic and died before the age of five years, and two were born with numerous fractures of the bones of the limbs, caused by the cannonading and explosion. These results ensued through the medium of the mothers'

alarm and the natural consequences upon her organisation. These facts are on too large a scale to be set down as mere "coincidences." (Dr. Carpenter).

(*g.*) Mr. Combe, in his "Constitution of Man," relates that a shoemaker called at his house and showed him his son, aged 18, who was in a state of idiotcy. The father said that his wife was of sound mind, and that he had three children which were of good intellect. The only account he could give of the condition of this son was, that he once kept a public-house, and some months before the birth of the boy an idiot lad came round with a brewer's drayman and helped him to lift the casks off the cart, and that the idiot made a strong impression on his wife, so that she complained of not being able to get his appearance removed from her mind. His son, he said, was weak in body from birth, and silly of intellect, and had the slouched and slovenly appearance of an imbecile.

(*h.*) I once knew a Mr. Wright, of Sodbury, who was known by the name of "cat-eyed Wright." The pupils of the eyes of this gentleman were elongated like those appertaining to the domestic cat. His mother stated to me that this result ensued through her one day, when pregnant, watching, with a kind of emotion, the action of the sun on the eyes of this animal.

(*i.*) Mr. Catell—one of my pupils—saw, December 3rd, 1853, the offspring of a woman, brought by herself—to fulfil the order of Mr. Furguson—to King's College. This child, in appearance, resembled a cat. The woman accounted for the malformation from the circumstance of her being frightened by this animal. Mr. F., whilst addressing his auditors, remarked that "children were said to be like angels, but this monster resembled a demon."

(*j.*) Dr. James Blundell, obstetric (relating to midwifery) lecturer at Guy's Hospital, showed me one day at his house a preparation preserved in spirits, and asked what it resembled. I proclaimed it to be a kitten's body, but the head simulated that of a parrot. The Doctor then stated that the mother-cat was when pregnant bitten by that bird, and the preparation before me was the result. Dr. B. then showed me another object also preserved in spirits, and he requested to know what animal I would liken it to. I exclaimed that it resembled a very large toad. The Doctor then related that a woman gave birth to the anomaly before me, after being terribly frightened by this batrachian reptile, which leaped from under a stone she was lifting from the ground.

(*k*.) In the year 1820, when residing in Berkely, Gloucestershire, I remember that the wife of Lieutenant Gafrick, was delivered of a child minus the right hand and part of the forearm. The lady stated that when pregnant she received a shock on beholding a man by the name of John Workman, who suddenly exposed to her view the stump of his arm that had been originally torn off by the machinery at the oil mills of the town.

EXTERNAL AGENTS AND THEIR MODIFYING EFFECTS.

(427.) All ponderable and imponderable bodies are continually modified throughout every stage of their being, by external undulatory agents. These qualifying influences—whether inborn or acquired—vary in their intensity, accordingly as they are proximate or distant; but be they near or far, these physical agents control, more or less, the development as well as the degeneration of every entity in the universe. Further, these pulsatory attributes ever issuing from surrounding existences, preside, in varying degree, over the animal, vegetable, and even the mineral world, influencing by their operation, the great as well as the most minute productions of Nature, promoting or retarding—according to time and circumstances—the formation and decay of all organic and inorganic bodies. Moreover the chemical action of materials, whether uniting or separating from each other, is modified by these undulatory properties.

(I.) The reflective faculties force upon us the conviction that we become the beings we are through the qualifying circumstances we may have been subjected to during our existence. These prompting contingencies, by their sway, modify the cerebral organization, and thus give rise to our propensities, for the brain-organs of man are especially operated upon, and even moulded—so to speak—by the influence of external agents. Further, the phrenological developments, by their innate vital action, give rise to our inclinations, which are indulged in according to the predominance of the organs that gave rise to them. Thus the individual with a good organization is governed by the useful and beneficent occurrences of life, whilst the person with a bad cerebration is ruled by the baneful events that may environ him.

(II.) Men, says Condillac, are ignorant of what they can do so long as experience has not led them to take notice of what they actually do from Nature only. Hence they have never effected by design, anything but what they had already done,

even without intending it. Men never thought of making analyses, until they found they had effected them. They were not informed of proclaiming by the language of action to make themselves understood, till they became aware that they were comprehended. In like manner, they would never have dreamt of speaking with articulate sounds, unless they had observed that they could converse with such sounds; and languages have commenced without any design of making them. It is thus that men have been orators and poets without thinking of being such. In a word, all that they have become first belonged to Nature alone, and they have not studied to be such, until they had noticed what Nature herself led them to do. She has commenced everything, and always well. If laws," continues Condillac, "are not conventional or agreed on, they are then arbitrary! There may have been despotic ones, but those which determine whether our actions are good or evil, are not such, nor can they be of that kind. They, the decrees, are indeed, our work, because they are agreements which we have made. But we have not produced them alone. Nature accomplished them with us. She dictated them, and we were incapable of making others. The wants and faculties of man being given, the laws themselves are bestowed; and though we make them, Nature, who has created us with such wants and faculties, is, in truth, our sole legislator. In following these laws thus confirmed to our system, it is Nature whom we obey, and this is what constitutes the morali y of actions.

(III.) Persons who lose their sight, are at first, inconsolable; the remembrance of ideas transmitted to them by vision is still recent, but by degrees they are reconciled, undoubtedly because they become accustomed to their misfortune, but probably also, partly from the organs of sight becoming more and more weakened, the ideas which are gained by it are enfeebled in the same proportion. When at length the eyes are entirely destroyed, after a time the impressions, which depended upon sight, are equally annihilated, and even the remembrance of these images lost. Darwin quotes the following examples: "A man 60 years old became deaf at 30. He appeared to be very intelligent, and amused himself with reading, conversation, and writing, or by making signs with his fingers to represent letters. I observed that he had forgotton the pronunciation of his language so far, that when he attempted to speak he articulated no word distinctly. His relations, however, could sometimes understand what he would say. He told me that

in his dreams he always imagined that people conversed with him by writing or by signs, and no one ever appeared to speak to him. Hence it would seem that with the perception of sounds, he had also lost the idea of the intonations themselves, although the organs of speech had still preserved a feeble remainder of their ordinary habit of articulation." "I had occasion to converse with two men," continues Darwin, "who had been blind for some years. Both told me that they never remembered having dreamed of visible objects after they became totally blind."

(IV.) The skulls of persons who have been blind for a period become depressed over the perceptive faculties, showing that these organs have shrunk *from not being exercised*. On the contrary, the perceptive faculties of infants are excited to enlarge, more rapidly through external agents, than any other part of the brain. The forehead of the child, from its previous flattened form, projects forwards, and it begins to fix its attention upon outward things, to compare them, to form abstract ideas, and to generalise. ("Gall," v. 2, p. 100.)

(V.) Injuries to the head have been known to awaken the faculties of certain organs of the brain. Haller mentions an instance of a person born an idiot, who by a wound on the head was cured of his imbecility, but relapsed into his former state after the wound had cicatrised. Boerhave reports the case of a boy of small capacity who had his abilities developed by a fall.

(VI.) Those persons who are incited to employ only one or two organs of the brain are prone to madness or an early death, as is the case sometimes with ardent priests, great composing musicians, and sensitive ideal poets; on the contrary, philosophers, who exercise most or all the developments of the sensorium, die sane, and live to advanced ages.

(VII.) Different divisions of the brain preside over and stimulate separate portions of the body, and when certain phrenological organs are disordered by over action, or become diseased by adventitious circumstances, they induce various maladies in particular tissues and certain distinct viscera.

(VIII.) The propensities of animals are subject to the control of the seasons. Thus, the inclination for singing, coupling, building, and providing for the future, &c., are sometimes in a state of activity, and at other periods in the condition of almost absolute repose. Some creatures lose a portion of their propensities when their food is altered, or if

the frigid regions he is dull, stupid, and moderate in his pacific desires. When situated beneath hot sunny skies he is violent in his affections, feeble in judgment, and given to animal pleasures; amid both extremes he manifests a mercenary soul. It is to the southern nations of Europe, both ancient and modern, that we are indebted for the invention and embellishment of that mythology, and certain ancient traditions, which even now present the most fertile field for the imagination, and an inexhaustible source of poetical allusions. We owe to them the romances of chivalry, and those succeeding models of a more rational style, by which the fancies are excited and elevated, and the spirit purified. The northern countries have been more fruitful in the productions of industry, and it is there that the sciences have received their most valuable additions; the efforts of imagination and of feeling have been more successful and common in the south. While the borders of the Baltic were made illustrious by the labours of Copernicus, Tycho Brahe, and Kepler, those of the Mediterranean produced men of genius in all departments, and abounded in poets and historians, as well as in philosophers.

The burning desires, the fiery passions, which are enkindled between the sexes in one climate, shrink into cold regard in another, or reciprocal pardon for mutual disgusts. One is struck by this difference when crossing the Mediterranean, on ascending the Mississippi, in crossing the mountains of Caucasus, and on passing the Alps, and the Pyrenees to the Baltic Sea.

On the frontiers of Louisiana woman governs by the double ascendency of superstition and passion. Among the natives of Canada it is said that she is a slave, and is valued only for her labours and domestic duties which are her lot.

(XIV.) Electrical states of the atmosphere have a remarkable influence on certain individuals, waking up strange sensations and oppressive feelings. Again, electricity hastens the growth of the vegetable world. Thus, some plants have been known to increase in a most extraordinary manner during thunder weather.

(XV.) Owing to the great dissimilarity of the nervous system, and to the different degrees of physical and mental refinement to which individuals have attained, *similar* objects do not cause every person to experience the same corporeal sensations or moral emotions. Some sensitive individuals will turn sick on beholding blood, others faint at the sight of a wound. A

beautiful structure will transport some minds with inexpressible delight, and it is exceedingly painful for such to gaze upon deformity. The human soul can by necessity become accustomed to disproportions; but health and harmony demand everything congenial with internal principles. The *form* of the globe, the *angularities* of the crystal, the characteristics of the vegetable and animal; and the *symmetrical* beauty of the human form, are the results of Nature's economy acting on man and each existence that surrounds him.

(XVI.) The living principle of the human race is surrounded by millions of influences, which are adequate to the development of mental and then *physical* afflictions. First, man inherits a *diathesis* (state of body) which is predisposed to some particular *local* manifestation of disease; *second*, he is subject to numerous diversified *accidents*, *lesious* or injuries; *third*, he is *particularly* influenced by the electrical and magnetic elements that may surround him; *fourth*, he is affected by *occupation*, or by his employments; *fifth*, by situation; *sixth*, by habits; and lastly by mental disturbances. It should be remembered that the *soul*, and not the body, is first affected by these influences; that sometimes they act individually, and at other periods in a state of concentrated combination, and that the legitimate consequences thereof are faithfully recorded upon the dependent system.

(XVII.) *Circumstances* often incite certain persons to self-destruction. "I have known," says Voltaire, "women kill themselves for the most stupid men imaginable."

(XVIII.) Locke demonstrated that man has no *innate* ideas or principles; how necessary then to instil just images and sound elements into the mind as soon as it acquires the use of its faculties. There is no inborn knowledge, for the same reason that there is no tree that bears leaves and fruit when it first starts above the earth. Nothing is inbred or fully developed in the first instance, all is unfolded through external agents.

(XIX.) *Fright* often changes the organic temperature, and confuses the motions of the formative atoms of the body, so as sometimes to change the hair to a perfectly white state. *Fear* developes various disorders, and even diseases, as hysteria, madness, and even death. Fear acts upon the bowels, as well known to men when going into the field of battle. The relation of bad personal news produces the same effect.

Voltaire relates that he once saw at a fair a young woman with four nipples, or rather dugs, and in addition what re-

sembled the tail of a cow hanging down between them. She was decidedly a monster when she displayed her chest, but was rather—he continues—an agreeable woman in appearance when she concealed her bosom. The mother had been frightened by a cow.

Dr. Prichard relates the case of a lady who was suddenly frightened by a negro, and she gave birth to a child covered by large black blotches. Another case is reported by Dr. Antonio, where a lizard jumped into the bosom of a pregnant woman, whose child had a fleshy excrescence like that animal growing from its breast, to which it adhered by the neck. Mr. Grant reports the case of a lady who gave birth to an infant covered with hair, and the claws of a bear, from contemplating this animal in a picture. I myself once knew a man who resided at Woodford in Gloucestershire—by name of John Sharp—whose mother used to work at the castle, and during the period of gestation she was sometimes found gazing at the portrait of Charles the Second. This woman once told the housekeeper that the man in the picture had a very strange effect upon her. In due course of time this personage gave birth to a male child who as he grew up became the exact image of the "merry Monarch," and from manhood into old age this personage was designated by the gentlefolks of the neighbourhood—and frequently by strangers—"Charles the Second." Dionysius was aware of these facts, hence he was accustomed to have beautiful pictures hung in his wife's rooms during her pregnancy. The Greeks were also well aware of these influences.

(XX.) *As regards the bias or sway of our associates.*—The habits of the mind are as infectious as those of the body, and by close contact the sentiments and principles of the beloved object are liable to be imbibed, like tastes formed, and a similar course of life desired. It is extremely important that the mind should be allowed to exercise itself solely according to the dictates of justice and benevolence, for those whom we love we try to please, and those we wish to gratify we endeavour to be like. If then our chosen friends be unworthy of imitation, our attachment to them must have injurious effects. For this reason, as well as from the capability of sympathy in causing us to take the tone and direction of our associates,the choice of them becomes highly influential upon our disposition. "Tell me a man's companions, and I will tell you what character he is" (Spanish Proverb).

(XXI.) Man would never be angry, or in a mirthful mood, unless made so through his surroundings, showing that our thoughts, feelings, propensities and even deeds, are excited into action from without. Certain emotions brought into being, or called forth by circumstances or particular occurrences, work strange effects upon us; for instance, Dr. Prichard relates a case that came under his experience where the hair grew white in a single day through grief; many similar cases are recorded by other authors.

(XXII.) *Locality in conjunction with circumstances produces great changes in animals and vegetables.*—The stature of man—states Quetelet—is materially influenced by his residence in town or country. The height of the inhabitants of cities at the age of 19, he states, is greater than that of the country dweller by two or three centimetres. Dr. Villerme remarks, that the stature of man becomes greater, and the growth takes place more rapidly—other circumstances being equal—in proportion as the country inhabited is richer, the comfort more general, house, clothes and nourishment better, and labour, fatigue, and privation less during youth, or in other words, the circumstances accompanying misery put off the period of the development of the body, and stint human stature. Exposure and cold, not to speak of toil, materially influence the growth of the human race. The warmth and luxury of cities rapidly develope the growth of all but the lowest classes. Individuals who enjoy affluence generally exceed the mean height; hard labour appears to be an obstacle to bodily development.

(XXIII.) The descendants of the English settlers in America display a considerable variation, in general form and aspect from the parent nation. The children of European dwellers in New South Wales are taller and weaker than their progenitors. Relative to the English settlers in the West Indies, their cheek-bones—like the aboriginal races—are higher, eyes deeper set in the head than those of the English breed. Again, the Africans of America are approximating to the white people, the mouth becoming smaller, nose higher in the bridge, hair considerably longer and less crisp.

(XXIV.) The mountaineers of all countries, especially in the temperate and warmer divisions of the earth are, as a rule, very tall and well formed, the men being handsome, and the women fairer and more beautiful than those dwelling in the lowlands. The chests are very much larger, which ensues

from the deeper respirations taken, in order to obtain a sufficient quantity to the rarer air they dwell in, thus enabling them to redden the blood in the lungs, &c.

(XXV.) It is fully established that a human family, tribe or nation, is liable, in the course of generations, to be either advanced from a lower form to a higher one, or degraded from a superior to an inferior condition, by the influence of the physical station in which it lives. The coarse features and other structural peculiarities of the negro race only continue while these people live amidst the circumstances usually associated with barbarism. In a more temperate clime, and higher social state, the face and figure become greatly refined. The few African nations which possess any civilization exhibit forms approaching the European, and when the same people in the United States have enjoyed a within-door life for several generations they assimilate to the whites amongst whom they live. On the other hand, there are authentic instances of a people originally well-formed and good-looking being brought by imperfect diet and a variety of physical hardships to a lower form. It is remarkable that prominence of the jaws, or recession, and diminution of the front part of the skull, and an elongation and attenuation of the limbs are peculiarities always proclaimed by those miserable conditions, for they indicate an unequivocal retroception towards the type of the lower animals. The style of living is ascertained to have a very great effect in modifying the human figure in the course of generations, and this even in the osseans (bony) structure. About 200 years ago a number of people were driven, by a barbarous and most cruel policy, from the counties of Antrim and Down, in Ireland, towards the sea-coast, where they have ever since been settled, but in unusually miserable circumstances, even for Ireland. The consequence is, that they exhibit altered features of the most repulsive kind, projecting jaws, with large open mouths, depressed noses, high cheek bones and bow legs, together with an extremely diminutive stature. These, with an abnormal slenderness of the limbs, are the outward marks of a low and uncivilised condition all over the world, and are particularly seen in the Australian aborigines. On the other hand, the beauty of the well-fed and clothed higher ranks in England is very remarkable, being, in the mean, as clearly a result of good external conditions. "Coarse, unwholesome and ill-prepared food," says Buffon, "makes the human race degenerate. All

by *external agency* in the vegetable kingdom are almost innumerable, and they are not confined to *structure*, being observed in habit also. Thus many plants, which are *annual* in a cold climate, become perrennial (perpetual) if transplanted to the torrid zone, and plants which are usually biennial—forming their organs of vegetation one year, and those of fructification in the second, and then perishing — may be converted into *annuals* by heat, or into trieneals by cold.

(XXIX.) *Hibernal or winter sleep of animals*.—This economy is said to be induced by cold, yet the Tauace, or rat of Madagascar, sleeps during the height of summer, changes in the system generally, and renewed activity of the various functions follow hibernal as they do diurnal sleep. The presence of light, *it is supposed*, causes most plants to wake up from their night sleep, but still some species of vegetation—like certain animals, repose through the day, and are awake at night. Further, it has been ascertained that the leaves of plants kept constantly in the dark open and close at regular intervals, thus carrying out the law impressed upon them by Nature. Plants and seeds are influenced by *external agents* in many ways, and vary according to soil, heat, moisture, light, &c. Thus, for instance, if the locality has not sufficient light the plant will be half blanched, spotted, diminutive, or even lose its hairs. If the light is too vivid, the vegetable will be stronger, smaller, more deeply coloured, harder, and more velvety than usual. In cold climates the same plants are smaller aad weaker than ordinary, the colour paler, the wood less firm, leaves deciduous (not permanent), fruit abortive. In hot districts the vegetation becomes larger, produces more wood, the leaves are brighter coloured, and more highly flavoured. In the same climate humidity causes difference of appearance without end; plants that grow in the water lose all their hairs, the stems of flower stalks lengthen to reach the surface of the stream or pond, and these different effects are further variable, as the brook is still or agitated, clear or turbid, pure, or mixed with heterogeneous substances. If, on the other hand, a plant accustomed to water is placed or found in a dryer soil, it is covered with hairs, becomes smaller and harder, and if growing on the mountain, they become more stunted, while their flowers are larger than upon the plains. The influence of soil is not less manifest, if it is tenacious, the roots are small, hard, and clustered, when it is very sandy the roots become large, fleshy, and fully formed; if it contains a

quantity of carbon the colours of the flowers are often altered; should there be salt, or if the plant is near this substance, or it is even brought through the atmosphere, the leaves become fleshy, and more glaucous (bluish green). All these different circumstances combined with each other in nature are fertile causes of varieties, which are still further multiplied by cultivation.

(XXX.) Young animals are observed to waste away when associated too much with the old. Thus youthful people put on the character as if withering away if allowed to sleep with those stricken in years; juvenile women become pale and thin who marry old men; the same is the case as regards young horses and other creatures, when confined for a lengthened period with those worn out by age.

(XXXI.) Every considerable alteration in the local circumstances in which each race of animals exists causes a change in their wants, and these novel needs produce in them new actions and habits. These later economies require the more frequent employment of some parts before but slightly exercised, and then greater development follows as a consequence of their oft repeated use. Other organs no longer employed become impoverished and diminished in size, nay, are sometimes entirely annihilated, while in their place new parts are developed for the discharge of novel functions.

(XXXII.) Climate and surrounding objects, combined with circumstances, and education, will alter men's propensities, and their liking for different foods, whether they be flesh or vegetables.

(XXXIII.) The swine carried from Europe to Cuba acquire double their original magnitude. It is the same with the bovine race when transported into Paraguay.

(XXXIV.) A marked difference is seen in respect to bodily development between the dwellers in the dark holes and crowded by-places of cities, and the free, unrestrained savage tribes of the earth. Speaking of the Chaymas, Humboldt makes the following remark:—"Both men and women are very muscular; their forms are fleshy and rounded. I have not seen a single individual with a natural deformity, and I can say the same of many thousands of Caribs, Muyscas, Mexican and Peruvian Indians, which I and my companions have been observing during five years.

(XXXV.) The deformities of the Cretins (certain idiots afflicted with goitre or wens), have been, among other causes

attributed to their residence in deep shady valleys, where the direct light of the sun seldom penetrates. Many maladies invade people who live even in darkened rooms.

(XXXVI.) If we could conceive a being to come into the world endowed with a perfect brain and every mental faculty complete, but all the inlets of sensation closed, there would be no mental *operation;* for it is *sensation* which is the necessary stimulus to any change in the mental condition. The being in question would remain in a torpid state, like a man in a profound sleep, possessing faculties, yet wanting the ability of using them, just as the seed buried deep in the soil possesses vitality, but does not germinate because withdrawn from the influence of the requisite stimuli.

(XXXVII.) The civilized man differs only from the savage through having been for ages associated with different educative circumstances, which developed his original organisation —especially his reflective faculties.

Further. The enlightener of earth's human dwellers merely vary from some of the creatures of the wilds through possessing greater functional abilities which are at the command of his inner selfhood. Again—It will be found that most of these dormant faculties owed their advancement to the stimulative province of external agents. In fact, all the propensities and capabilities of living beings lie in abeyance, merely awaiting the exercise of some exciting agent to bring them forth into operation, as we see relative to the course of action in different seeds and winter-sleeping plants, and their co-existing animated beings, whose inner properties or qualities only lie quiescent until some external cause developes or excites them to exercise their destined economy.

(428.) *Educability of the spirito-vital faculties of animals* (*see sec.* 429, *page* 399).—It is through external agents that the creatures of the wilds demonstrate certain courses of action, and domestic animals their capabilities of executing particular feats after being trained, which achievements are illustrated in the subjoined anecdotes.

(*a.*) It is related by Lyall, in his geology, that a pig was taught by the keeper of Mr. Toomer, at Broomly Lodge, New Forest, to hunt and point game with activity and steadiness. Other learned adepts of the porcine species have been trained to spell, by means of letters, persons' names, and to execute many other feats.

(*b.*) One of my brothers once taught the common house cat

to fetch the animals he killed with his gun, which apparatus miss puss knew as well as her master, and would become very excited at hearing the click of the lock, when this implement of death was procured from the rack.

The cat, on hearing the sound in question, always solicited to be taken to the fields. This she effected by leaping into the shooting jacket pocket, which was held open by my brother for that purpose. Miss puss, whilst in the pouch of the coat, always rested her head on its edge, so as to be ready for her duty when called upon to fetch a dead bird.

(*c*.) Pliny tells us that an elephant, having been scolded for his inaptitude in executing some feat which he was required to learn, was observed at night endeavouring to accomplish that which he had vainly attempted in the day. Plutarch mentions another elephant that practised his theatrical attitudes alone by moonlight. The elephants were educated by the Romans with all gentleness, and instructed by kindness. The horse is often made vicious by a harsh driver, and the ass acquires his hereditary obstancy from constant ill-treatment.

(*d*.) Pigeons have been incited to keep time to musical performances, and to distinguish false notes, and they also seemed to be pleased with certain airs in preference to others.

(*e*.) A gentleman of Cambridge taught a snake to glide through his fingers, if held a little distance before its head (after the manner of the cat, who has been educated to jump over the joined hands); this animal would sometimes lie for hours on the table, near its master, or around the upper bar of his chair. A lady once tamed one of these reptiles to come at her call, and also to follow her about the house and garden. A herd-boy succeeded in teaching one of these anguine creatures to coil and uncoil round his arm, when he wished it to do the one or the other.—*Chambers' Papers.*

(*f*.) Major Buckley related to me that when in India he possessed an elephant that was taught to pick up things that might have fallen from his houdah, and present them to the parties therein seated. Sometimes ladies purposely dropped their gloves, which were taken off the ground and delivered to the owners, but if this experiment was repeated too often, the elephant would discover that the article in question was thrown down for amusement, and then the animal placed his hoof upon it, and after grinding the glove in the soil, he would deliberately present it to the person who had let it fall; at the same time making a trumpet-noise through his proboscis, by

way of letting the party know that he was aware of their object.

When elephants are required to execute extraordinary tasks they may be made to understand that they will receive an unusual reward. Some favourite dainty, for instance, is shown them, in the hope of acquiring which the work is done; and so perfectly does the nature of the contract appear to be understood that the breach of it, on the part of the master, is often attended with great danger, as was witnessed during the late Burmese war.—(" Lyell's Geology.")

(*g*.) The bullfinch and robin, when placed in a room with the Virginian nightingale, will soon acquire and go through the same notes as the latter warbler, but in a lower and softer tone. The bullfinch has often been taught to whistle certain airs very sweetly. Domestic birds often recollect their former keepers, after years of separation; cage songsters have frequently been perceived to be dreaming.

(*h*.) Goldsmith relates that he once saw an otter, who, at the word of command, would drive the fish up into a corner and then seize the largest among them and carry it to his master. Mr. Bell mentions another case where an otter used to catch fish for a poor woman he knew.

(*i*.) Mr. F. Cuvier relates that he once saw a seal which had been taught to raise itself erect on its hind legs when requested so to do, and then take a staff under the flipper ; like a sentinel, it obeyed the word of command, would lie on the right or left side, according to order, make a summersault when solicited. It gave the paw, if desired, like a dog, and would protrude its lips for a kiss, and was remarkably fond of its master.

(*j*.) The fishermen on the coast of China and the Mozambique are known to educate a particular kind of fish (a species of echinus, or ramora) to catch turtle for their trainers. (" Penny Cyclop.," v. 25, p. 76.)

(*k*.) Carp are said to be very cunning, hence called "river foxes." They have been taught to feed out of the hand, and come to their trainer when whistled to through a rod, the lower end of which was dipping in the water. (" Selborne.")

(*l*.) Relative to the common river-pike, Dr. Warwick succeeded by kindness in affectionately attaching to his person one of these voracious fishes.

(*m*.) Dr. Jenner, the discoverer of that blessing to the human race, vaccination, possessed a black terrier, who well knew

when his master was feigning to leave the house, and could never be deceived. For instance, the Doctor would sometimes take down his hat and procure the walking-stick, and then in jest exclaim to his daughter, Catherine, "I am going for a stroll;" but unless he was leaving the domicile for his usual perambulation, his canine friend, Tartar, never moved from his accustomed couch of rest.

(*n.*) Mr. Lee, in his anecdotes of Birds, relates that it is a common practice in some parts of Tartary for hunters of game to train eagles to catch foxes and antelopes, &c.

(*o.*) One of our officers of the 44th Regiment, when in France, relates that on walking sometimes across one of the bridges that spans the river Seine he used to have his clean boots bedaubed by a poodle dog, the owner of which was a shoe-black stationed at the other side of the river. The gentleman in question one day taxed the polisher of boots with the artifice and, after a little hesitation, the man confessed that he had taught the dog to roll in the mud of the Seine, and then to besmear the clean shoes of the passengers to procure customers for himself. The officer, being much struck with the dog's sagacity, purchased him at a high price, and brought him to England. He kept him tied up in London for some time, and then released him. The dog remained a few days with his new friend, but at last made his escape. A fortnight afterwards the poodle was found with his former master, pursuing his old trade on the bridge. ("Jesse.")

(*p.*) Dogs and birds have been taught to imitate death, like spiders, the former remaining motionless even when whipped, and the latter lie as if lifeless, though a train of gunpowder was fired which surrounded them. (See sec. 433.)

(*q.*) The Roman elephants were taught to march to music, and could perform many evolutions; they reclined at table, fed themselves, were polite to each other, and drank with moderation. Pliny relates that Germanicus exhibited elephants that could hurl the javelin up into the air and catch it whilst descending; they would fight with each other like gladiators, could execute the Pyrrhic dance, and perform on a rope. Four of them would traverse cords, carrying one of their companions in a litter. Other historians relates that some elephants were taught to walk backwards on the tight-rope.

(*r.*) The celebrated Astly once had a horse that would ungirth his own saddle, wash his feet in a pail of water, bring into the riding-room a tea table and its appendages; then

fetch a chair and a stool, and even take the kettle off the fire. It would dance to music, affected lameness, feigned death, and allowed himself to be dragged about in this state. ("Chamber's Anecdotes.")

(429.) PASSIONS AND PROPENSITIES APPERTAINING TO ANIMALS.

The study of the nervous system appears to the philosophical inquirer a field infinitely more vast than is supposed. The brute tribe, mostly the object of contempt, resulting from the ignorance and pride of man, share so many things with him, that the naturalist finds himself sometimes embarrassed to determine where the spirito-animal life terminates, and the abilities of the human soul commence. Animals are produced, born, and nourished, according to the same laws as man; their muscles, vessels, viscera, and nerves, are almost alike, and exercise similar functions and analogous senses, of which they make use after the same mode; they are subject to like affections, to joy, sadness, fear, alarm, hope, envy, jealousy, anger; and have for the most part our propensities. They are naturally inclined, as we are, to propagation—they foster and love their young; have attachment for each other and for man; are courageous, and fearlessly defend themselves and theirs against enemies. Like us they feed on vegetables and other animals. They have the sense of *property*, and while some are cruel and sanguinary, others take delight in theft, some are sensible to blame and approbation, are mild, docile, compassionate, and mutually assist each other. Some are wicked, indocile, wayward, obstinate; they retain the recollection of benefits and injuries, are grateful or vindictive, cunning and circumspect, foresee the future by the past, or by what has been unintelligibly termed *instinct* (but which is in reality *clairvoyance*, like that of the human race) which causes them to take the necessary precaution against the dangers which menace them. They correct their false judgments and unsuccessful enterprises by experience; have the idea of time, and foreknow its periodical return; possess memory, reflect and compare, hesitate, and are divided by the most urgent motives; are susceptible of a certain degree of individual perfectibility; and even form obstructions. By means of articulate language, or by gestures, they communicate their ideas, wants, and projects. They acquire more sagacity and knowledge by virtue of the circumstances which force them to be clear-sighted and

cautious. They balance the evil consequences of certain actions which their memory recalls to them, with actually stimulating desires. They seem to follow a deliberate plan of conduct agreed upon between several individuals; they know each other, sing, and are sensible to the harmony of music; have an astonishing local memory, and perform long journeys. A great number among them build, some even count. Very often their actions denote a sentiment of morality, of justice, and injustice, &c., &c.

The greater part of animals are not limited wholly to the means of their own preservation. They are susceptible of much more extended instruction than their immediate wants require. We teach all sorts of tricks to birds, squirrels, cats, dogs, horses, monkeys, and even pigs. They also modify their own mode of action with reference to the position in which they find themselves. But this faculty of receiving education is always proportionate to their primitive faculties; and they cannot, any more than man, learn things of which they have not received the first impress from Nature. We admire the setter, couching in the pursuit of the pheasant; the falcon, in chase of the heron; but the ox will never learn to run after mice, or the cat to browse on grass, and we shall never teach the roebuck and the pigeon to hunt.

(*a*.) The ardent temperament of the partridge has been the theme of many writers, from Pliny downwards; and the parental affection of the female for her young seems to be not less strong than the sexual ardour of the male, which latter watches over the young with great parental care. Pennant relates that a partridge, followed by a large covey of very young birds, was surprised by a violent hail-storm The mother collected them under her; and to secure them further, spread her wings to prevent every injury in vain! The storm increased, yet she would not quit her charge: she preferred death, and was found lifeless (and all the little brood) with distended wings, retaining her attempt to preserve them even to the very death. Mr. Selby relates that a person engaged in a field not far from his residence had his attention arrested by some objects on the ground, which, upon approaching, he found to be a male and female partridge engaged in a battle with a carrion crow: so absorbed were they in the issue of the contest, that they actually held the crow till it was seized and taken from them by the spectator of the scene. Upon search, the very lately hatched young were found concealed in

the grass, and the crow had been doubtless attacked by the parents during his attempt to carry off some of their offspring. The wiles and stratagems put in practice by the hen to draw the intruder from the place where her affrighted young have taken refuge are often wonderful: she will limp about as if lame of a leg or wing, and so induce one unaccustomed to her deceptions to follow her from the brood, to which she flies back by a circuitous route.

(*b.*) *Peacocks.* "I find"—states Sir R. Heron—"that individuals of this tribe differ as much in temper as human beings, some are willing to take care of the young of others, whilst some have pursued and killed them, and this whether they had a brood of their own or not. Certain cocks assisted in the care of the young, whilst others have attacked them. The hens have frequently a preference to a particular peacock. At one period the females were all so fond of an old pied male that when he was confined in view they were constantly assembled close to the trellis walls of his prison, and would not suffer another peacock to touch them. The females always make advances or court the males. The peahen, like other gallinaceous birds, will sometimes put on the plumage and spurs of the male, when unfit for the reproduction of the species." According to Hunter, the egg-bag and ovaduct of these become atrophied or wasted away.

I once knew a Mr. Oldland, of Woodford, Gloucestershire, who possessed a hen of the common domestic fowl breed, which, after assuming the male plumage and spurs, used to crow like any other chanticleer.

(*c.*) *The bald eagle* is the most courageous of birds, is a very daring robber, plundering the vulture. which, in hard times, it forces to disgorge its carrion to satisfy the depredator's appetite. Eagles can master the red buzzard and herons, and have been known to destroy the American ostrich. They sometimes hunt the larger animals in companies of four or five together.

(*d.*) Mr. White, of Selborne, relates the circumstance of the punishment inflicted by some hens upon a hawk, which had at different times killed their chicken. This falcon was one day caught and given up to the tender mercies of the bereaved mothers. The wings of this destructive bird were clipped, his talons cut, and a cork having been fixed on his bill, he was thrown among the brood of hens. Imagination cannot paint—states Mr. White—the scene that ensued, the expression that fear, rage, and revenge inspired were new, or at least such as

strike him in the eyes, coming, going, and returning so swiftly, which feat no one would believe who had not seen it. This pugnacious audacity probably fostered the Mexican belief that these diminutive bodies contained the souls of slain warriors.

(*k.*) *Swallows.*—A pair of these hirundinous birds having constructed a nidal abode, the female laid her eggs therein and proceeded to sit on them. Some time after incubation the male was observed to be flying about the nest, and was heard to utter very plaintive notes, which betrayed his uneasiness. On a nearer examination, the female was found to be dead, and the people flung her body away. The male proceeded to sit on the eggs for a few hours and then vacated the nest, and after a time returned with another female, which sat upon the eggs, and after hatching them, fed the young till they were able to provide for themselves. ("Selborne.")

(*l.*) *Geese.*—Mr. Brew, of Ennis, relates the presentiment of an old goose that had been for a fortnight hatching in a farmer's kitchen, who was perceived on a sudden to be taken violently ill. She soon after left the nest, and repaired to an outhouse, where there was a young goose, which she brought with her into the kitchen. The young one immediately scrambled into the old one's nest, sat, hatched, and afterwards brought up the brood. The old anserine bird, as soon as the young one had taken her place, settled down by the side of the nest, and shortly after died.

(*m.*) *Canary.*—Lord Kaimes relates a circumstance of one of these birds which fell dead whilst singing to his mate, who was in the act of incubation. The female instantly quitted the nest, and, finding him dead, rejected all food, and after a time died by his side.

(*n.*) *Sparrow.*—Mrs. O'Brian, of Chelsea, once possessed a canary, with whom a sparrow set up a friendship as it hung in the garden. This latter bird would often alight upon the top of the cage and chirp to the canary, and at length a reciprocal conversation ensued. The sparrow would remain a few minutes and then fly away, but would return with a worm, &c., in his bill, which he dropped into the cage. This conduct was manifested day after day, till they became so familiar, that the canary would at length receive the proffered food from the bill of his generous friend.

(*o.*) *Lapwing or pewits.*—This bird chiefly lives on insects, but these failing in winter, necessity compelled one of these insectivorous feeders that a gentleman kept in his garden to

approach the house, from which it had previously remained at a watchful distance. A servant hearing its feeble cries—as if it were asking charity—opened for it the door of the back kitchen. It did not venture far into the scullery at first, but became daily more friendly, and then emboldened, as the cold increased, it at length entered the cooking apartment, though already occupied by a dog and cat. By degrees it at length became so familiar with these animals that it entered regularly in the evening, and established itself always in the chimney corner for the night: but as soon as the warmth of spring returned, it preferred roosting in the garden, though it resumed its place near the fire the next winter. Instead, however, of being afraid of its two old friends—the dog and cat—it now treated them as inferiors, and arrogated to itself the place which it had previously obtained by humble and timid solicitation.

(*p.*) *Rooks* (*corvus frugilegus*).—A gentleman, who had lived on the banks of the Delaware, relates that he had reared one of these birds, with whose tricks and society he used frequently to amuse himself. This rook lived for a long time with his family, but at length disappeared, having—as it was supposed—been shot. About eleven months after this, as the gentleman, one morning, in company with some friends, was standing on the river's bank, a number of rooks happened to pass by; one of them left the flock, and flying directly towards the company, alighted on the gentleman's shoulder, and began to gabble away with great volubility, as one long-absent friend naturally does on meeting with another. On recovering from his surprise, the gentleman instantly recognised his old acquaintance, and endeavoured, by several civil, but sly manœuvres, to lay hold of him, but the bird not relishing so much familiarity, and having now had a taste of the sweets of liberty, eluded all his attempts, and suddenly glancing on his distant companions, mounted into the air to join them, and was never afterwards known to return.

Rooks are sometimes seen to hold, as it were, courts of justice. To join these councils they are perceived to arrive from all quarters, as if they had been summoned for the occasion. A few of the flock sit with drooping heads, and some seem as grave as judges, while others again are exceedingly active and noisy; in the course of an hour or so they disperse, and it is not uncommon, after they have flown away, to find one or two left dead on the spot. ("Lee's Ancedotes.")

I reollect witnessing such a scene as the above, in the summer of 1824 in a field near a wood not far from Berkeley Castle.

(*q.*) *Pigeons.*—Mr. Jesse relates, among his anecdotes of animals, that he once had a solitary dove, who affectionately kept company with an old chanticleer, whose presence it seldom left, roosting at night by his side in the hen-house. The cock always seemed to be most sensible of the attachment of the pigeon. Mr. Jesse further reports that he at one time had a pigeon which was confined and made to pair with another of her tribe; but one day, on being released, she forsook her new mate and her two young ones eight days old in order to return to a former partner, and although flying about in the neighbourhood, she never again came near them.

(*r.*) *Asp* (Vipera Haje).—This serpent never lives alone, the male and female being constantly found together, and if one happens to be killed, the other seeks with the utmost fury to avenge its death. This animal knows and selects the destroyer from among crowds; it follows him to a great distance, surmounts every obstacle, and can only be deprived of its revenge by the most speedy flight or the intervention of some rapid river. The jugglers of Grand Cairo have the art of taming the haje, as those of India do the cobra capello, taking care however to deprive it of its fangs. ("Penny Cyclop.")

(*s.*) *Elephants.*—One of these animals is sometimes excluded from the society of its fellows. Such elephant is always vicious and mischievous, attacking whatever approaches him, and passing herds will not permit him to join them. He is generally known and spoken of as the rogue elephant. The forgoing economy sometimes occurs among the buffalo tribes of North America.

(*t.*) *Seals* (Phocidœ.)—They are a harmless race, never attacking man unless in defence of themselves or young. One of Anson's sailors lost his life by exasperating a mother, in whose presence he skinned her young one. Their disposition is however gentle and affectionate. A young seal petted by a seaman, became so attached to its master from kind treatment, that it would come to his call, allow him to mount on his back, and put his hands into its mouth. During the breeding season, however, bloody battles take place among the males, in which they are often severely wounded, but rarely killed, while the female calmly wait the issue, and receives the conqueror. The phocidœ are polygamous, and live in families, every male being surrounded by a crowd of females (from 50 to 80 whom he guards with the greatest jealousy.) ("Penny Cyclop.")

(*u.*) *Spaniels.*—These dogs are remarkable for their sagacity and attachment, and will seek their masters through every difficulty. Colonel Hardy relates in his memoirs that he had been sent for to Bath and took his spaniel with him in the chaise, which he never quitted but for short periods till his arrival there. After remaining four days, he returned to his residence at Springfield, in Essex, but accidentally left his dog behind. In three days after arriving home, his faithful spaniel returned to his master's domicile. The distance between the above two places is 140 miles, and it is stated that the dog had to explore her way through London, to which she had never been but in her journey to Bath, when she was in a close carriage. It is recorded of another of these dogs that in 1792 a gentleman who lived in Vere Street went with part of his family to Drury Lane Theatre, leaving a small King Charles spaniel locked up, to prevent the chance of the loss of the dog. At 8 o'clock his son opened the door, and the dog, unperceived, passed out into the street and made his way to the playhouse, where he found his master, who was seated nearly in the centre of an unusually thronged pit.

It would appear that this species of dogs have neither peace or rest when separated from their owners. If excluded from a room, they will lie at the door so that no one can go out without their knowledge, and when in the room with their mistress, some will not go to sleep, even when wearied, except upon a portion of her dress, so that she cannot rise from her chair without giving them notice. The faithful spaniel of Robespierre clung to him during his mock trial, was with him at the guillotine, and died exhausted on his grave. Colonel H. Smith in his works on dogs gives an account of a spaniel who was lying on the grave of his mistress for three days at Plymouth, refusing all food, and was obliged to be removed by force.

(*v.*) *Moles* (Talpidæ).—During the season of love, bloody battles are fought between the males. The sexual attachment is very great among the talpidæ. Le Court states that he often found a female taken in his trap, and a male lying dead close to her.

(*w.*) *Tortoise* (Testudo.)—"I was much taken with its sagacity, "states Mrs. White, of Selborne, "in discerning those that do it kind offices, for as soon as its mistress—who had waited on it for 30 years—comes in sight, it hobbles towards its benefactress with awkward alacrity, but remains inattentive to strangers."

(*x*.) *Apes* (Simiæ).—The Ungka-puti, a species of ape, is a very affectionate creature; it has been known to seek out and fondle a baby, laying its face close to the cheek of the infant, which remained perfectly at ease under the caresses of its long-armed strange companion. It at times seemed to have some fun about it, for it would at periods lie in the bosom of the gentleman to whom it belonged, look up kindly into his face, and then with its long arm passed round him—apparently thinking of nothing at all—pick his waistcoat pocket, opposite to the side on which it was reposing, of anything on which it could lay its lean, lengthened fingers. It was very fond of playing with people, and in the same spirit it would frolic with its companion, the orang. Light as a fairy, and quick in its unerring motions as a bird, it would sportively elude all the efforts of its comparatively unwieldly Caliban of a playmate to catch it. As regards the wild siamang apes, however numerous the troop may be, if one is wounded by the hunters it is immediately abandoned by the rest, unless indeed it happens to be a young one, then the mother, who either carries it or follows close behind, stops, falls with it, and uttering the most frightful cries, precipitates herself upon the common enemy with open mouth and arms extended. But these animals are not made for combat; they neither know how to deal or shun a blow. Nor is their natural affection displayed only in moments of danger; the care which the females bestow upon their offspring is so tender, and even refined, that one would be almost tempted to attribute the sentiment to rational rather than to what has been vaguely called *instinct*. It is a curious and interesting spectacle, which a little precaution enables one to witness, to see the females carry their young to the river, wash their faces in spite of their outcries, wipe and dry them, and altogether bestow upon their cleanliness a time and attention that, in many cases, the children of our own species might well envy. The young siamang apes, whilst yet too weak to go alone, are always carried by individuals of their own sex, by the fathers if they are males, and by the mothers if females. These creatures frequently become the prey of the tiger, from the same species of fascination or animal magnetism which serpents exercise over birds, squirrels, and other small creatures. ("Penny Cyclop.")

430.—FRIENDSHIP, ATTACHMENT, AND SOCIALITY OF ANIMALS

(*a*.) *Orang-autan* (man of the woods,)—Captain Decaen once

had a male orang whose affection was almost exclusive for himself. One morning this fond creature entered the captain's cabin before he rose, aud in the excess of its joy, threw itself upon him, embraced him with perfect transport, and applied its lips to his chest, to suck his skin, as it was accustomed to do the fingers of its most favourite acquaintances. Another of these orangs conceived an affection for two kittens. This animal generally employed himself in nursing one or other of the favourites, and sometimes was amused by putting one of the young cats upon his head, but on such occasions he was sure to suffer from the kitten's claws, and it was highly amusing to witness the patience with which the orang resigned himself to this singular fancy, and the rueful contortions of countenance which accompanied it. He was often observed to examine the feet of the little animals attentively, and having discovered their claws he endeavoured to pull them out with his fingers, but failing, he afterwards became resigned to his fate, and preferred enduring the pain to giving up the pleasure which this sort of enjoyment afforded him.

Mr. F. Cuvier, in describing a female orang, states that, in order to defend herself, she sometimes bit and struck with her hand. It was, however, only against children that she showed any kind of resentment, and then apparently more from jealousy than anger. Generally speaking she was gentle and affectionate, and showed a propensity to live in society. She was fond of being caressed, gave real kisses, and appeared to experience great pleasure in the act of sucking peoples fingers. Her voice was shrill, but only heard when she ardently desired something that was withheld from her; then all the actions became highly expressive, she knocked her head, panted, and when very angry would roll upon the ground and utter loud and harsh yells.

(*b.*) *Leopard.*—In captivity this animal is very playful, but apt to be treacherous. Mrs. Bawdish won the affections of one of these creatures by kindness, and, by presenting him with lavender water in a card-tray, this lady taught him to keep his claws sheathed. The luxurious animal revelled in the delicious essence almost to ecstacy, but he was never suffered to have it if he put forth his claws. The common house cat is fascinated in the same way with the odour of valerian.

(*c.*) *Jaguar or American Panther* has been known—when it had young—to leave the woods and play with the Indian children. ("Penny Cyclop.")

(*d.*) *Cat and Bonnet-monkey.*—These two animals, by association in the same cage, became greatly attached to each other, but sometimes—like human beings—they disagreed. Thus puss, whilst attempting to go to sleep, was one day teased by the monkey, who persisted in putting a straw up her nose. The cat not liking this repeated operation gave pug a rather severe cuff, and he being offended at the rebuff, seized poor puss by the tail and leaped to the top of the cage, and there held her whilst he inflicted many smacks and pinches before liberating his friendly companion.

(*e.*) *Sheep.*—A Scotch gentleman relates that while passing through a lonely district in the Highlands, he observed a sheep hurrying towards the road before him, as if to interrupt his progress, and at the same time bleating most piteously. On approaching nearer, the animal redoubled its cries, and, looking significantly in the face of the traveller, seemed to implore some assistance at his hands. Touched with a sight so unusual, the gentleman alighted, and, leaving his gig, followed the sheep to a field in the direction whence it came, there, in a solitary cairn (a heap of stones), at a considerable distance from the road, the distressed creature halted, and the traveller there found a lamb completely wedged in between two larger stones, and struggling feebly with its legs uppermost. The gentleman extricated the little sufferer, and then its overjoyed mother poured forth her thanks in grateful demonstrations.

When a sheep becomes blind it is mostly—says Mr. Youatt—in this helpless state solaced and watched by some one of the flock which attaches itself to the afflicted animal, and by bleating, calls it back from the precipice, lake, or pool, and every kind of danger.

(*f.*) *Horse and Sheep.*—Mr. O'Kelly relates a case where a strong attachment was once formed between a sheep and a race-horse; the latter would sometimes nibble the neck of the former, and without hurting, would lift it into the manger of a neighbouring shed belonging to the field next the horses paddock, as much as to say, although you are not able to reach it, I will help you to the banquet. Besides this, the horse would on all occasions protect his ovine friend, and would suffer no one to offer it the slightest molestation.

(*g.*) *Horse and Hen.*—Great disparity of kind and size does not prevent social advances and mutual fellowship. Thus Mr. White, among his anecdotes of the affections of animals, relates the circumstance of a horse and hen entertaining a great

friendship for each other. These two incongruous animals spent most of their time together in a lonely orchard. The fowl would approach the quadruped with clucks of complacency, rubbing herself gently against his legs; while the horse would look down with satisfaction, and move with the greatest caution, lest he should trample on his feathered companion.

(*h.*) *Elephants.*—One of these animals, reported in the *Philosophical Transactions*, formed such an attachment for a very young child, that he was never happy but when near it. The Indian nurse used, therefore, frequently to take the infant in its cradle and place it between the elephant's feet. This he at length became so accustomed to, that he would never eat his food except when the child was present. When the infant slept, he used to drive off the flies with his proboscis; and when it cried he would move the cradle backwards and forwards, and thus rock it to sleep.

There was a soldier at Pondicherry who was accustomed, whenever he received his share of liquor, to carry some of it to a certain elephant, and by this means a very cordial intimacy was formed between them. Having drank too freely one day, and finding himself pursued by the guards, who were going to take him to prison, the soldier took refuge under the elephant's body, and there fell asleep. The guard tried in vain to force him from this asylum, as the animal protected him most strenuously with his trunk. The following morning, the soldier, recovering from his drunken fit, shuddered with horror to find himself stretched under the belly of the huge animal. The elephant perceived the man's embarrassment, caressed him with his trunk, to inspire him as it were with courage, and made him understand that he might now depart in safety.

(*i.*) *Sociability of Animals.*—There is a remarkable spirit of sociability in the brute creationand other animals, independent of sexual attachment. The congregation of gregarious birds in winter is an attractive example. Many horses, though quiet with company, will not stay one minute by themselves; they, and even cattle, have been known to leap out of a stable window, through which the litter is thrown—to join with others. Oxen and cows will not fatten by themselves, but neglect the finest pasture that is not recommended by society. Sheep are well known to flock together.

(*i.*) *Horses—friendship between.*—There were two of these

animals which had assisted in drawing the same gun during the whole of the Peninsular war. One of them being killed in an engagement the survivor was picketted as usual, and his food brought to him, but he refused to eat, and kept constantly turning his head round to look for his companion, and often calling him by a neigh. Every care was taken; and all means that could be thought of were adopted to induce him to eat, but without effect. Other horses surrounded him, but it paid no attention to them; his whole demeanour indicated the deepest sorrow, and he at last died from hunger, not having tasted food from the time his companion fell. "Selborne."

(*k.*) *Deer.*—Mr. White reports the case of a doe that was brought up from a fawn with a dairy of cows; it went with them to the field and returned in their company to the yard. The dogs of the house took no notice of this deer, being used to her, but if strange dogs came by, a chase ensued; but the hunted animal led over hedge and stile till she returned to the cows, who, with fierce lowing and menacing horns, drove the assailants quite out of the pasture.

(*l.*) *Cow.*—Mr. Jesse relates an anecdote of a lady who once made a pet of a calf, and often fondled it when a heifer. The gentlewoman afterwards became so circumstanced that she lost sight of the animal for some years, but one day whilst walking in a lane she met some cows, when one of them left the herd and came up to her, showing evident symptoms of pleasure in seeing the lady, who immediately knew and patted her old acquaintance.

(*m.*) *Leveret and Cat.*—The Hon. Danes Barrington had a little helpless leveret brought to him, which the servants fed with milk out of a spoon, and about the same time his feline companion kittened, and the progeny were dispatched and buried. The young hare was soon lost, and supposed to be killed. However, in about a fortnight, as the master was sitting in his garden, he observed the cat, with tail erect, trotting towards him, and calling with little short purring sounds of complacency, such as these animals use towards their kittens, and something gambolling after, which proved to be the leveret, that the cat had supported with her milk, and continued to supply with great affection. Thus was a graminivorous creature nurtured by a carnivorous and predaceous one.

(*n.*) *Horse.*—Occasionally equine attachment is as exalted as that appertaining to the human race. For instance.

During the Peninsular war, a French trumpeter had a fine charger assigned to him, of which he became passionately fond. The horse, by his gentleness of disposition and uniform docility, equally evinced its affection. This animal became unruly and useless to everybody else, and was always obliged to be again and again restored to his old friendly rider, who had the most perfect command over him. This horse carried the trumpeter during several campaigns through many difficulties. At last the corps to which he belonged was worsted, and the trumpeter was killed. Dropping from his horse, his body was found many days after the engagement stretched on the sward, with his faithful charger standing beside it. During the long interval he had never quitted the trumpeter's side, but had stood sentinel over his corpse, scaring away the birds of prey, and remaining heedless of his own privations. When found, he was in a sadly reduced condition, partly from loss of blood through wounds, but chiefly for want of food, of which, in the excess of his grief, he could not be prevailed upon to partake. "Chambers' Anecdotes."

(o.) *Cobra di capello* (hooded snake).—Mr. Cross, in Exeter Change, had for some years within one cage a canary and a death-dealing cobra. These incongruous animals appeared to be most affectionately attached to each other.

(p.) *Hedgehog.*—Mr. Jesse had in his possession one of these spine-covered quadrupeds, which used to nestle before the fire on the stomach of an old lazy terrier dog, who was much attached to it, and the best understanding existed between them.

(q.) *Dogs.*—Mr. Glenthorn relates that he once had a pointer and a Newfoundland dog. The former broke his leg, and during his confinement the latter brought him a share of his food, and would often sit for long periods by the side of his suffering companion.

(r.) *Alligator.*—An American gentleman once succeeded in taming one of these reptiles when young, which would follow him everywhere, even upstairs; but its great favourite was a cat, and the friendship was mutual. When puss was reposing herself before the fire, the alligator would lay himself down, place his head upon the cat, and in this position go to sleep. If puss was absent the reptile became restless, but always tranquil and happy when the cat was near it.

(s.) *Ants.*—These insects play with each other like kittens or young dogs. Huber describes the hill-ants, when approaching each other, as moving their antennæ (feelers) with astonish-

ing rapidity, while they patted with a slight movement the cheeks of their companions. Bennet describes a small species of ant, which employed themselves in carrying each other on their backs, the rider holding on with his mandibles (jaws), then they wrestle and part, and afterwards embrace in play, and again separate to renew the sport. Ants recollect and greet their associates, after being separated for months. They always share everything with their companions, and if they find any edibles, they inform the community, and even conduct their friends to the place where the food lies, or communicate through insect language by means of their antennæ the direction where the provender is situated, which fact I myself have often witnessed.

(*t.*) *Earwigs* (Farficula auricularia), like birds hatch their eggs, and are remarkably affectionate to their young, of whose safety they are not a little jealous. They have a numerous brood, which nestle under their mother like chickens beneath a hen.

(*u.*) *Tree-bugs* (Acanthosama grisea).—These creatures, like earwigs, sit upon their eggs; the brood, consisting of 30 or 40, follow the mother like chickens do a hen. She never leaves her family, and as she moves the young closely follow, and assemble around her in a cluster wherever she makes a halt.

(*v.*) *Spiders.*—These arachnidan animals sit upon or near the silken bag which encloses their eggs; which depositary the mother guards with intense anxiety, and she is most affectionately attached to her young.

(431).—PUGNACITY OF CERTAIN INSECTS.

(*a.*) *Butterflies.*—These papilianaceous insects are very contentious, and drive away rivals from their haunts. The blue argus butterfly is very jealous and pugnacious. It will not suffer any of its tribe to cross its path, or approach the flower on which it sits.

(*b.*) *Praying mantis.*—This insect is a terrible cannibal-like animal, and often enters upon the most deadly combats. It dexterously guards and cuts with the edges of the fore claws, as the hussar does with his sabre, and sometimes by a stroke the one can cleave the other through and sever its head from the body; the conqueror always devours its antagonist. The male and female fight, kill and eat each other, equally as when of the same sex. The Chinese take advantage of the ferocious habits of these insects to procure amusement by plac-

ing two of these creatures in a bamboo cage to make them fight. This proceeding is only outdone in barbarity by the cock-fighting, fox-hunting, and bull-baiting of our own country.

(*c.*) *Bees.*—These honey-collecting and wax-forming insects are often desperate fighters, and kill all strangers from other hives. They wrestle, turn, pirouette, and throttle each other, and after rolling about in the dust, the victor, watching the moment when the enemy uncovers his body, thrusts its sting between the scales of the opponent, and the next instant its antagonist stretches out the quivering wings and expires. Bees will thieve from each other, and sometimes band together like corsairs, and then go out to rob the nests of other apisine communities.

(*d.*) *Ants.*—Many of these forminidæ will in their life economy fight obstinate and fatal duels, and also pitched battles, and even form plans of these engagements, in which great numbers are often killed. They travel long distances to steal slaves, and also keep farms of aphides (plant lice) upon whose sacharine secretions they feed.

(432.) *Cunning of animals as regards feigning death.*—The migratory corn-crake, or land-rail, puts on the semblance of death when exposed to danger, allows itself to be handled without stirring a feather or the eyelids; the partridge will also feign to be lifeless, as well as certain insects, as beetles, also spiders, and the sea-mouse.

(433.) *Conjugality among animals.*—Marriage, or living together for life, is not peculiar to the human race; connubial union is a *natural* institution. Thus the fox, marten or weasel, wild cat, mole, eagle, sparrow, hawk, pigeon, swan, nightingale, common sparrow, swallow, and other creatures, unite in pairs for life. After the breeding season is past, they remain in company, make expeditions together, and if they belong to animals which live in herds, the species remain always near each other.

(434.) *Thieving propensities in animals.*—Gall, speaking to a friend of his whilst feeding his birds, observed: "You see they all know me, and will feed from my hand, except this blackbird, who must gain his morsel by stealth before he eats it; we will retire an instant, and in our absence he will take the bread. On our return," continues Gall, "we found the bird had secreted the food in the corner of his cage." I once, when studying insanity at Hanwell Asylum, knew a madman who

would never partake of food unless he could purloin it. He had a large organ of *Acquisitiveness*, or theft.

(435.) *Emasculation* (castration).—This operation has a strange effect on the habits, passions, and affections of animals. It alters the character of both man and beast, and likewise birds, and brings the male to a near resemblance of the other sex. Thus eunuchs have soft muscular arms, thighs, and legs; broad hips, beardless chins, and squeaking voices. Gelded stags and bucks have hornless heads like hinds and does. Again, wether sheep have small horns, after the manner of ewes. Oxen possess large bent horns, and hoarse voices when they low, like cows; on the contrary bulls have short straight horns, and though they mutter and grumble in a deep tone, yet they low in a shrill key. Capons have small combs and wattles, and look pallid about the head, as do pullets; they also walk without any parade, and hover over chickens like hens. Barran, or gelded hogs, have small tusks like sows. If a boar's tusks be broken, he loses all his venerous desires and ability. After castration animals mostly lose their spirit, but once an Irish horse ran at a man, seized him with his teeth by the arm, which he broke, he then threw him down, and lay upon him. Every effort to get him off proved unavailing, and they were forced to shoot him. This horse had been emasculated by this man some time before.

(436.)—*Relative to the phrenological developments being the seat of our passions and propensities, and also the source of certain maladies.*—"Would any one," asks Gall, "whilst annotating upon the viscera in regard to their influence on animal passions and propensities, maintain that the heart of the tiger is the organ of cruelty—in the sheep the seat of gentleness—in the lion that of courage. Many animals have the liver very large, although we do not remark in them any of the qualities which has been attempted to palm upon this viscus. The wolf, the tiger, the hare, and beaver, have the same viscera, yet their inclinations, appetites, and mechanical aptitudes are very different and even contradictory." "We know," continues Gall, "that impressions being felt in certain parts, in connection with the affections and passions, proves nothing as to the seat of our sympathies. Jealousy chokes us, commiseration painfully contracts the jaws and palate; amorous emotions excite violent sneezing; the sentiment of benevolence bring tears into the eyes; anger produces colic; and indignation causes the knees or lips to tremble. Fretting, fear, anxiety,

grief, and especially fits of anger, acts on the mammary secretions, especially the latter, which renders the mother's milk injurious, producing sickness, diarrhœa, and even the death of the offspring. The halitus (vapour) from the lungs is sometimes almost instantly affected by bad news, so as to produce fœtid breath. Dogs, like the human species, have sometimes been known to produce fits and even dissolution through suckling their young after having had a contest with some animal or another dog.

(437.) *The love of offspring depends on organization.*—There are numerous families of insects, amphibious animals, and fishes, the males and females of which do not trouble themselves about their young. Among birds, the cuckoo is entirely a stranger to the love of offspring. But the owners of the nests where she deposits her eggs nourish with great care the voracious young cuckoo. If taken from the nest and placed in the aviary with other birds, or if exposed in a garden, all the birds around seem anxious to adopt and feed it.

(438.) The old superstitious suppositions were that many of the ailments of the mind arose from certain disorders or diseases attacking the different viscural organs of the body, and further it was conjectured that these organs governed in a greater or lesser degree our systems. From these fanciful ideas, there sprang up a kind of nomenclature, indicating particular mental disorders. There was also an assumption that these moral passions had their origin directly in distinct visceral members of the body. Thus, a person affected with gloom, jealously, or disagreeableness, was said to have a "fit of the *spleen*," or be "splenetic." The melancholy or hypochondriacal disposition was attributed to the *liver*, as were revenge and frequent bursts of anger. Certain ardent propensities were assigned to the *kidneys*, or renal organs. Further, our ancestors were accustomed to speak of or refer to the *liver* as if it were capable of certain passions. Thus, this viscus was thought to have the capacity or to be full of goodness when appertaining to the generous, and large in those who were brave; on the contrary, in cowards it was said to be small. At the present day a man is still called "*white livered*" when he is deceptive or incapable of friendship. The *spleen* was deemed to be small or worthless in those persons easily given to despondency or dejection, whilst with the very jealous, churlish or obstinate, it was said to be large. A person who was cold in disposition, or possessed of little affection, was

reckoned as having diminutive *kidneys*. If he was full of ardour, then these organs were considered to be large. Benevolence was supposed to reside in the intestines, hence the phrase "*bowels* of compassion." Very many mental emotions and sympathies were said to reside in or belong to the *heart*. These absurd ideas relative to the last-named organ still possess the minds of most people, as exemplified by their speaking of a good, hard, soft, bad, large and little heart; in fact, the unreflecting, or those not acquainted with physiology, attribute a hundred different propensities to this viscus, appertaining to humanity, as if it was the mind or soul, instead of being merely a hollow muscular apparatus. The Egyptians, as did the inhabitants of India before them, believed the heart to be the principal seat of the soul, hence this organ was imagined to be the source of all passions, the attributive phraseology alluding to which has descended to our own times.

The planets were said by the ancients to act on different organs of the body. Thus Jupiter was imagined to influence the *liver*, Saturn the *spleen*, Mercury the *lungs*, and Venus was held as presiding over the kidneys; and I would here remark that the foregoing assigned sources of the human passions originated from ignorance of the true fountains from whence sprang our emotions. To ascribe feeling and mental excitement to the *heart* in reference to affection or malevolence is as ridiculous as that of attributing love to a toe-nail, or like imagining that spitefulness could reside in a lock of hair. The heart has no more to do with propensities or dispositions than has the pulsating artery in the foot, or beating blood-vessel at the wrist. People do not allude to heart qualities when speaking of animals. The heart (except when blessing a pet) is left altogether out of the question when describing the temperament or disposition of a horse or dog, &c. Anatomy and physiology, assisted and proved by our later knowledge of the *organs* of the brain and the capabilities of the nervous system, have revealed to us that the heart, with its cavities enveloped by contractible muscles, merely serves to momentarily propel, through the agency of the brain's *magnetic energy*, the blood of the system to all parts of the body.

The heart of the embryo infant is a mere canal, nearly straight, and then becomes curved, as we see in insect life.

The deductions in past periods, and in our own times, which led people to ascribe sensations and passions to the heart, &c.,

were that in this organ they felt uneasiness or pain from certain experiences, or mental disturbances. But, the knowledge derived from modern discovered phrenological *facts*, assisted by reflection or reason, point out to us that these sensations are *effects*, resulting from a distinct action taking place in the nervous system, and in no way can be the *cause* of our feelings, or the source of the sufferings or endurances of which we hear persons speak as emanating from the heart, &c.

A little meditation must, I think, satisfy the enquirer that it will be after the eye has *seen* something, or the ear has detected certain sounds, or the sense of *touch* has conveyed to the mind particular feelings, that the heart is found to palpitate, or become stilled from fright, as in syncope or fainting. Again, the sudden boundings of this organ may be occasioned from excessive joy, through *hearing* pleasant or exciting reports, or from *seeing* some beloved face. Further, it is the impressions made on a *distant portion* of the brain (as the phrenological organ of *attachment*, by education, or experienced through friendship or love, &c., that causes the heart to ache from disappointed expectation. All our emotions will be found to occur from actions taking place in things absent from, or in organs and developments not resident in, the heart. The rapid beating sounds, or palpitating throbs—when not diseased—of this hollow muscle, may be likened perhaps to the moving and ringing bell. The cause of its commotion will be found at a distance either effected by someone at the gate, or by a person in another chamber of the building, who, by pulling the handle attached to the wire connected with the apparatus in question, gives rise to the recognised sonorous agitation.

It may be asked what conversational term I would propose to make use of in place of employing the word heart to point out some of our present ideas as to its capacities. For lack of verbal ability in the existing state of knowledge, of recognising the exact sources from whence spring the causes of the effects in question, we might substitute the term feeling or inclination (which results of course originate primarily in the mind-governed brain), and when alluding to certain experienced qualities, instead of saying bad, good, revengeful, sad, and affectionate heart, we could express ourselves thus—bad, good, sad, revengeful, affectionate, or loving propensity, or feeling, &c., &c. In this way we should avoid deceiving ourselves and others, and employing vague or erroneous expressions. Further, instead of stating that such a man had a good or kind

heart, we might proclaim that he was affectionate and benevolently disposed. Again, in place of pronouncing that a certain person had a bad *heart*, we could observe that the individual was unamiable, deceptive, illnatured, or ungrateful.

It has been discovered by phrenologists that there are particular portions of the brain which distinctly and positively preside over the functions of each separate viscus. For instance, the organ of *Adhesiveness* or attachment, will, when brought into action, affect the *heart* in a most evident and effective manner. It is now well known that the cerebellum, or small brain, termed by Gall *Amativeness*, has dominion over the reproductive organs, but the medulla oblongata (that portion of nervous matter which connects the small with the large brain) governs the muscular system. Many physiologists, and especially phrenologists, have noted, that accordingly as certain developments are large or small, active or passive, so will be the *condition*—as to character and *predisposition to disorder and disease*—of the liver, spleen, kidneys, stomach, and other parts and tissues of the body. In further confirmation of the proof that different developments of the brain act mediately, and sometimes immediately, on distinct parts of the body, I quote the following from a daily paper, May, 1873:—"Dr. Ferrier, of Aberdeen. His experiments on the brains of animals. The creature to be operated upon is first put under the influence of chloroform. The next thing done is to clear away the skull and expose the brain. Dr. F. then applies the point of an electrode (the surface by which electricity passes into and out of different media) to the convolutions of the sensorium. Its effect is to excite the functional activity of that part, and thereby to show what its real vocation is. One of the first experiments disclosed the part which is used in wagging the tail. Soon after, the centres employed in supplying the limbs, the mouth, head, &c., were discovered, and already Dr. F. has succeeded, to a degree, in *mapping* out the brain, with all its organs or developments distinguished by the sure and rigorous test of experiment. Nothing could exceed the interest produced by the manipulations. On the table before you is the dog with the skull removed. All seems—but for the breathing and movement of the brain—an inert mass of matter. The Dr. applies the electrode, and presently the tail begins to wag. All else is motionless. Another touch, and the head is elevated; another, and its mouth opens. Again, the magic wand touches the sensorium, when the animal seems convulsed with

fear or *rage*, and fits like epilepsy and chorea, or St. Vitus's dance were elicited, spasmodic rigidity, and other particular states of the body were artificially produced," &c., &c.

The foregoing effects, from the application of *electrodes* to the naked brains of sleeping animals, will recall the attention of many persons to the varied results frequently produced upon the human subject in past periods, both by mesmerists and electro-biologists, and will render individuals of the present day unacquainted with animal magnetism more capable of appreciating *Phrenology;* a science which most positively displays how and whence spring our varied propensities. These recent electrical experiments on the lower animals remind me of the effects I first saw developed on various persons thirty years ago, by the application of the *finger* to the different organs of the head, which proceeding called forth the separate propensities appertaining to our systems. This digital process was at that time—as now—termed *phrenotyptics*, as indicative of the manipulator's capability of acting on the mind through the touch or tap of the finger.

I would here observe that the animal—as far as our present experience extends—only answers to electro-magnetic appliances in the *chloroform sleep;* but it has often been demonstrated that the human being can be acted upon when sent to sleep, either through animal magnetism, chloroform, or nitrous-oxid gas, and also frequently responds to certain manipulations in the natural sleep. It has likewise been recognised in very many cases that the touch of the operator's fingers will elicit or arouse into activity the propensities resident in children and adults, when fully awake, or in the common or ordinary condition of life, as witnessed when influenced by the *electro-biologist*, who effects the same results on an individual's developments merely by means of his magnetic will-energy, making the party acted upon display every propensity belonging naturally to the human family. This latter process or ability, exercised by these electro-biologists, is termed *phreno-magnetism.*

OPTICS.

439. Optics. — (Gr. optomai, I see)—That branch of physical science which treats of light and vision. Relative to this branch of knowledge—as it is now taught—light is regarded as proceeding from the object to the eye, in three different ways. 1st.—*Directly*, or without any change in its course; 2nd, in a direction which is bent or refracted like a rod, when it is thrust into a transparent fluid—and, 3rd, in a path, where, meeting some other object, it becomes *reflected*—like the thrown ball—after striking a solid surface. All visible objects may be divided into two classes—1st, *self-luminous*, as the sun, stars, flames of every kind, and bodies which shine by being heated; and 2nd, *non-luminous*, as those that have not the ability of throwing off light from themselves, but reflect back the luminous rays which fall upon them from light-giving objects.

I. Buffon in 1747, with a combination of plane or flat mirrors (amounting in number sometimes to 400), placed in a square frame, and brought to bear upon the object by means of screws, succeeded in melting lead and tin at the distance of 50 yards, and in burning light substances at a space of 75 yards. These results were effected in March. With summer heat, and a better apparatus, he states, that he no doubt could have produced combustion at 140 yards, a remoteness probably double that which Archimedes effected his conflagration.

II. Shadows are not seen as realities; we know them only by privation. Darkness and coldness are negative terms, and only express the absence of light and heat.

III. When we observe a light beyond a sheet of water at the horizon, we perceive a long luminous train which follows our motions, showing that luminous rays, or rather their effects, spread in all directions, by reason that the elementary matter of light exists *everywhere* and in *all things*, and re-acts when acted upon.

IV. The rays of light—like ponderable bodies—are robbed of their intensity of motion by reflection, and deflected, according to their angle of incidence or direction of fall. See p. 89 (*a*).

V. Light is partially polarised or rendered incapable of reflection and transmission in certain directions, when it is reflected from polished metallic surfaces, and also when cast back from the clouds, the blue sky, and the vapour that forms the rainbow.

VI. A variety of colours like those in the feathers of a peacock's tail, appear upon pressing—when in the dark—on the corner of the eye. This result is produced by exciting into action the fibres of the phrenological organ of *Colour*, which wakes up in the brain the memory or the iconographed (image written) operations of certain tints, like we hear music in a dream, when the developments of *Melody* and *Time* burst into action as these organs become pressed upon by the pillow during sleep. Or it may be that the applied pressure to the eye stimulates the nervous fibrillæ, making up the brain development of *Colour*, to take cognizance of the tinted matter present in all medica, and of course resident in and around the phrenological development in question.

VII. The long-sighted eye receives a greater benefit as regards vision by means of light—from a convex lens, than the short-sighted eye does from one that is concave. For an object observed—as regards the organs of vision—through a convex lens, is not only magnified, but is seen brighter by the eye receiving a larger pencil of light from each visible point, on account of the rays entering it, being less divergent. On the contrary, a concave lens, not only diminishes objects, but also renders them darker, because the rays are thus transmitted more diverging to the eye, and consequently the pupil cannot receive so many of the reflected and emanating luminous undulations as it otherwise would.

VIII. *Absorption of light—and its associated colour elements.* If bodies—as is generally supposed—took up or assimilated the luminous rays that fall on them, they must *accumulate* in the recipient substances in question, which must then become permanently lighted up, and of course would assume a kind of phosphorescent character; but the fact is that the undulatory motion of these beams is merely arrested, and of course their intensity of operation is overcome, like that of the flying missile after striking against an opposing object. Now the light—and its intermixed colouring matters—being imponder-

able, cannot—like the arrested missile—gravitate after contact, and are, therefore, when rendered,to a degree inoperative, imperceptibly diffused, and afterwards conducted or radiated away by, or into the surrounding media.

IX. The nearer we approach objects, the more distinct they appear to our perceptive faculties. This result ensues in consequence of the undulatory qualities from adjacent things being of greater *intensity* than when they are remote; for it is well known that the *quantity* of qualitative pulsatory vibrations from bodies is the same, whether we are close to or far from them. Again: Light, according to its brightness or vehemence, enhances the operative action of the undulatory attributes, always emanating from every substantive entity. It is through these pulsatory qualities, bursting from all bodies at all times —which are enhanced by light—that they are enabled to engrave, or rather *iconograph* (image-write) themselves on surrounding objects, which is readily detected when they act on very sensitive surfaces, as we see demonstrated in what has been erroneously termed the *photographic* process. See p. 28, 319, 320, 321.

X. The true reason why we perceive a continuous circle on whirling round a burning fire-stick, is, that the operation acts on the nerve-fibres of that portion of the brain which appreciates light and colours, &c., and throws them into a trembling motion for the time being, like the quivering string of an instrument that is seen to vibrate for a period after being excited into sounding action.

XI. If it was through light alone we saw objects, all entities would appear as though close to the eye, as exemplified in people after couching for cataract. It is then by habit, or rather through education, that in our ordinary state, the brain judges of the *correct* distance of substantive things. If it was solely by means of the eye we perceive objects, the brain would not require instruction by experience. Clairvoyants, somnambules, as well as chickens, and other animals, need no practice to become apt in regard to this subject, the young of the domestic hen judge of space the moment after leaving their shells.

XII. On squinting with both eyes we see each object double, but not if we shut one of the organs of vision and squint with the other. Here the mind can attend only to certain of the effects produced by light. The same result ensues—for a

time—when strabismus (obliquity of vision) is induced from injury.

XIII. Further: If we saw objects solely by the means of light we should of course perceive everything upside down, since the luminous rays reflected from our surroundings imprint themselves in this position on the retina. (The net-like expansion of the optic nerve.)

XIV. The eyes may be in every way perfect, but if the brain behind them—which appreciates all objects—become disordered or diseased, the human mind and life principle of animals cannot receive cerebral intelligence by means of the eyes.

XV. People have often become blind of one eye without being in any way conscious of the defect, until discovered by accident. If it was through the organs of vision *alone* we took cognizance of the objects that surround us, this imperfection should have been made evident at once or by degrees to the person minus the natural capability (whatever that may be) of the organ in question.

XVI. *As regards the colour-rays intermixed with those of light.*—It is found that each elementary imponderable tinted ray situated in a beam of light, when separated and insulated from its associated hues, is found to be incapable of further decomposition, like one of the *simple* or single constituents of compound ponderable bodies.

XVII. *Colour-blind people.* These persons can see and estimate the presence and form of things but not their tints. This fact shows that it is not the eye that appreciates the hues of objects, but a piece of brain-matter, viz., the phrenological organ of *Colour*. It has been calculated that one out of every 18 persons are Colour-blind. See pp. 25, 26, 54.

XVIII. As much light is propagated round a corner or screen, as sound; which, as regards the latter, can be readily exemplified by taking a tuning-fork, and holding it (when set in vibration) about three or four inches from the ear, with its flat sides towards the auditory apparatus; the sound will then be distinctly heard. Thus let a strip of card somewhat larger than the flat of the tuning-fork be interposed at about half-an-inch from the trembling instrument, and if the card be by turns removed and replaced in quick succession, alternations of sound and silence will be perceived; proving that undulations of sound are by no means propagated with equal intensity by the circuitous route, round the edge of the card as by the direct one. Indeed any person has only to be convinced of the fact

to attend to the sound of a carriage in the act of turning a corner from the street in which it happens to be, into an adjoining one.

XIX. Light when polarised has been proved to have sides; thus the common luminous ray is cylindrical, whilst the polarised beam is four-sided, like a prismatic rod, proving that light, like the elements of sound and ponderable matter, is capable of being thrown or moulded into form. See *Chladni's Experiments on Sound*.

XX. *Luminosity.*—In proportion as we lose in intensity we gain in volume; the light becomes weaker the further it is from the burning body, but be it observed that it is filling a wider space. Here again an imponderable element puts on the character of gravitating matter, which loses ability accordingly as it is diluted or rendered less intense.

XXI. *Refraction of the rays of light.*—The two sides of a pane of window-glass not being perfectly parallel to each other, objects seen through it appear as if distorted, and as the obliquities in the glass are very various, the distortions are equally grotesque and numerous. Some windows are purposely ground on one surface to produce universal and minute refraction, and thus so great a confusion is introduced among the rays, that objects—in our ordinary state—are not distinguished through the glass. It has been found that, by means of an able refraction, objects at a great distance, or situated round the back of a hill, or considerably beneath the horizon, are brought into sight. This optical illusion has been called by the French, *mirage* (see p. 78), and is very common at sea, especially in high latitudes, and sometimes witnessed on land, particularly in Egypt and Persia, and on the margins of large sheets of water. This phenomenon arises from the unequal refraction in the lower strata of the atmosphere, and causes remote objects to be seen double, as if reflected in a mirror, or to appear suspended in the air. When this effect is confined to apparent elevation, the English sailors call it *looming*; when inverted images are formed, Italians give it the name of *Fata Morgana* (castles of the Fairy Morgana.) Ships in the whale fisheries are often discerned and sometimes known at great distances. Captain Scorsby recognised his father's vessel—without knowing he was at sea—30 miles off, being 17 miles beyond the horizon and some leagues past the limit of direct vision on the ocean.

PRELIMINARY REMARKS.

It is intended throughout the forthcoming work to point out certain novel characters in regard to the influencing attributes of MATTER—by displaying through particular facts—the true agency that the atomized and unatomized or ultragaseous worlds, exercise in the economy of Nature. Added to which, will be an investigation into some of the more abstruse Laws governing the various kinds of MOTIVITY. Also an inquiry touching the action of the LIFE-PRINCIPLE as it manifests itself, whilst governing the development of the vegetable and animal kingdoms. Further, the MATERIALITY of ELECTRICITY, HEAT, LIGHT, COLOURS, ODOURS, and SOUND, are considered, demonstrating that these principles have most of the characteristics of corporalities—save that of ponderability or weight. In addition, will be a disquisition touching the qualitative causes of RESISTANCE, and lastly will be annotations on GEOLOGY and ASTRONOMY.

LITERARY NOTICES.

We have been favoured with a perusal of a portion of Mr. Hands' Work on "MATTER, &c.," and can speak of it as a most able and interesting contribution to scientific literature.—*The Modern Physician.*—May, 1879.

Mr. Hand's Essays on Matter, Motion, Life and Resistance, &c., are replete with instruction and original conceptions of a very striking character.—*Human Nature.*—June 20th, 1879.

Mr. Hands, of Hammersmith, author of some very interesting works, has now adopted the plan originated by Dickens and Thackeray, whose books were brought out in monthly instalments. Mr. Hands's views are most original and illustrated by facts, his language stimulates the mental taste, like that of Robert Burton and Dr. Johnson, and pleases whilst instructing the reader.—*The Sussex Daily News.*—June 18th, 1879.

Mr. Hands has issued the second (July) part of his "New Views of Matter, Life, Motion, and Resistance." In many respects, this thoughtful and industrious author has trodden paths which are also explored by Dr. Babbitt, in his great work on "Light."

These writers are pioneers in new fields of scientific research, and as such, a duty falls to their lot which cannot be attributed to a selfish motive. Mr. Hands is a true author, and gives to his readers profound original thought, at a popular price, his single object apparently being the education of the public mind in all its multitudinous forms.—*The Medium and Daybreak*, July 25, 1879.